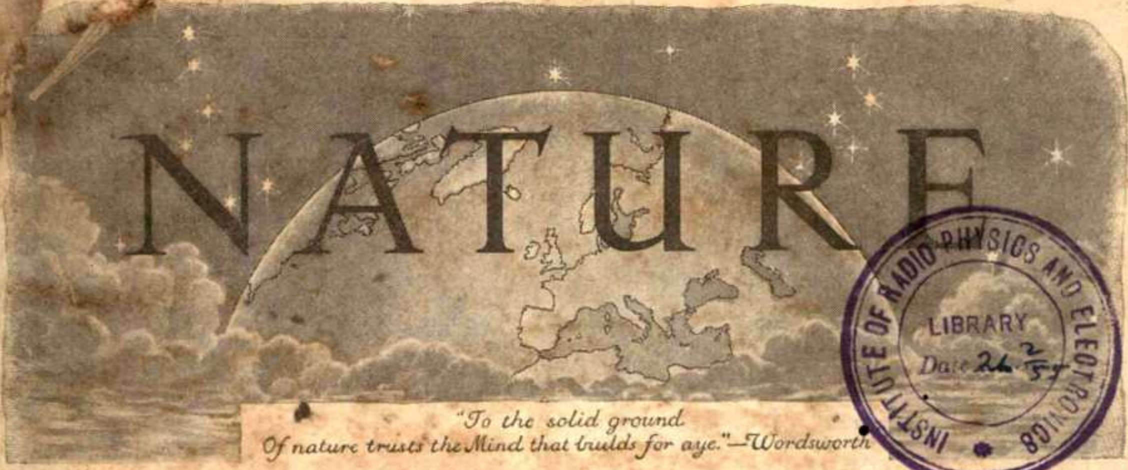


NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

INSTITUTE OF RADIO PHYSICS AND ELECTRONICS
LIBRARY
Date 26-2-55

VOL. 175, NO. 4444 SATURDAY, JANUARY 1, 1955 TWO SHILLINGS

173

THE Newton

LONG WORKING DISTANCE ATTACHMENT

. . . provides a working distance of 12.8 mm. between object glass and specimen when fitted to a standard microscope in conjunction with a conventional 4 or 8 mm. objective.

A further important feature is that the use of this attachment eliminates image reversal and thus further facilitates examination and manipulation of specimens.

Distributed by: Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, 17.
Member of the A.E.I. Group of Companies N/A 101

For Ultra-violet absorption research

Vitreosil Spectrophotometer Cells are made from specially selected transparent fused quartz, which has a high efficiency in the Ultra-violet range. The Cells have fused joints and are available in a standard range of sizes suitable for most spectrophotometer equipment. The standard sizes of Vitreosil Cells can be supplied matched if required.

VITREOSIL PURE FUSED QUARTZ
SPECTROPHOTOMETER CELLS

THE THERMAL SYNDICATE LTD.
Wallsend, Northumberland. Telephone: Wallsend 63242
London: 12-14 Old Pye Street, Westminster, S.W.1

Temperature Measurement

Send for lists on—

Mercury-in-Steel Thermometers (LIST T/40)
Electrical Thermometers (LIST E/30)

Post free on request

Negretti & Zambra, Ltd., 122 REGENT STREET, W.1 REGent 3406

Manufacturers of instruments for the indication, recording and controlling of—temperature, pressure, liquid level, volume, specific gravity, humidity, etc.

BRANCHES: *Birmingham · Cardiff · Glasgow · Leeds · Manchester · Nottingham*

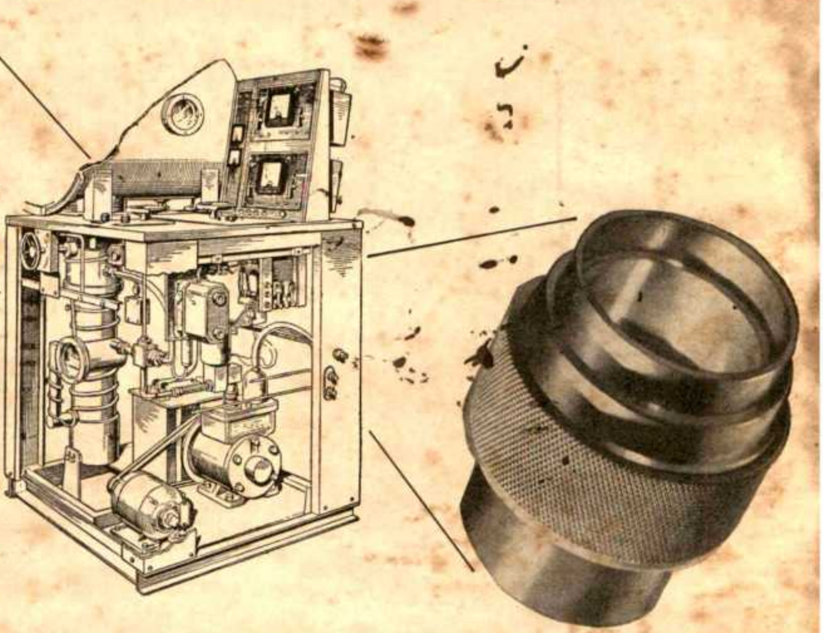
AGENTS OVERSEAS: *Argentina · Australia · Belgium · Canada · Czechoslovakia Denmark · Egypt · Eire · Finland · France · Greece · Holland · Iceland · India · Italy · New Zealand · N. Ireland · Norway · Portugal · S. Africa · Spain*

Technical Service available in most countries

Taking the 'Frowns' from HIGH VACUUM PLUMBING

Nothing can be simpler than screwing down a metal ring by hand, and that is how easy becomes the complicated business of 'plumbing' high vacuum systems when 'SPEEDIVAC' vacuum unions are specified. Simple design and precision vacuum engineering eliminate long-standing problems—just a few turns of the wrist and you have a permanent, rigid, leak-proof connection—and it's just as simple to take down when necessary.

Sizes from 1/16 in. to 2 in. diam.



W. EDWARDS
& CO. (LONDON) LTD
MANOR ROYAL · CRAWLEY · SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

for better vacuum service

BRANCHES: GLASGOW & TORONTO. AGENTS THROUGHOUT THE WORLD

CASELLA LONDON

DEW POINT APPARATUS
IMPROVED MODEL

This instrument will interest any person or organization concerned in the measurement of the dew point or relative humidity of air in large or confined spaces.

The re-design permits a more rapid appearance and disappearance of the dew formation, while an insulated thermometer of greater length enables more accurate temperature readings to be taken.

AVAILABLE FOR EARLY DELIVERY

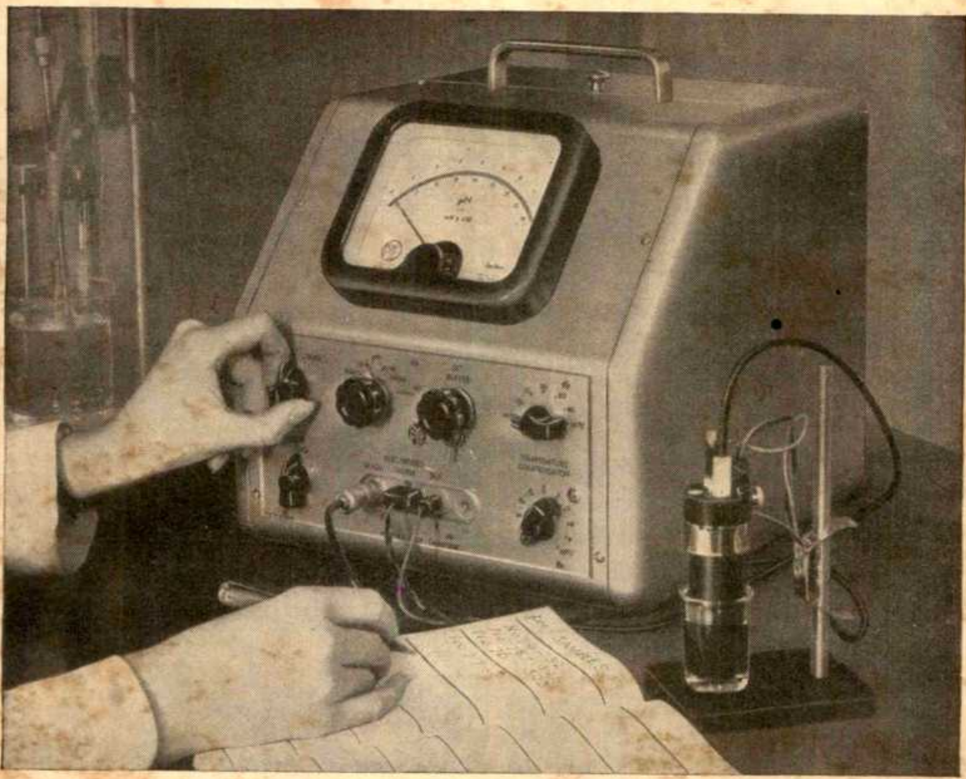
Price £5 10s. 0d.

C. F. CASELLA & CO. LTD.
REGENT HOUSE, FITZROY SQUARE,
LONDON, W.1

Telephone: ★EUSton 3944

Member Scientific Instrument Manufacturers' Association of Great Britain

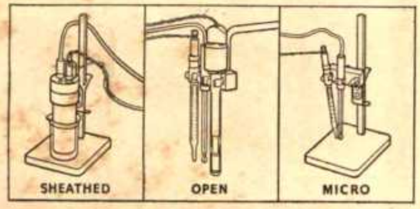
RP303



Ask users about the **PYE pH METER**

AND MILLIVOLTMETER

DIRECT READING — MAINS OPERATED



Electrode Kit to make up all the assemblies illustrated and all necessary accessories are supplied complete with the instrument.

Many leading industrial laboratories are using the Pye Universal pH meter and millivoltmeter to their complete satisfaction. Read what The British Aluminium Company Limited says:

"*. . . we write to inform you that our recommendations for the purchase of a number of these equipments for use in our Routine Laboratories have been accepted. You can expect, therefore, within the next week or so to receive orders from a number of our factories. . . . We feel you would like to hear from us this tangible proof of how satisfactory we found your instruments.*"

Signed: Director of Research.

May we send you details of this and other instruments in our comprehensive pH range?

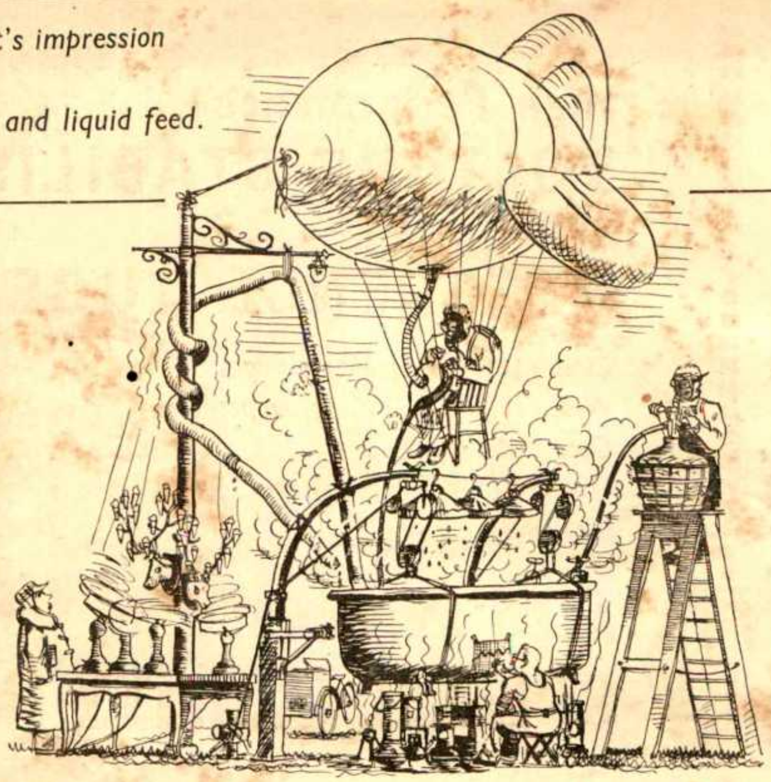
STANDARD EQUIPMENT IN MANY LEADING LABORATORIES

SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO. LTD., GRANTA WORKS, CAMBRIDGE, ENGLAND

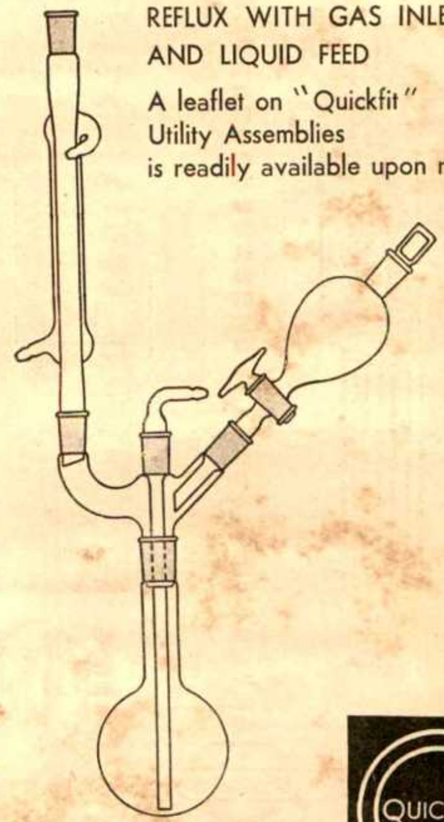
W G 59

*Our cartoonist's impression
of Reflux
with gas inlet and liquid feed.*



The quicker way
is the
"QUICKFIT" way!

The "Quickfit" General Utility Set provides the laboratory and research worker with the maximum number of assemblies from the minimum number of parts. No less than fourteen different assemblies, including reflux, distillation and gas evolution, can quickly be erected from a selection of eighteen pieces.



REFLUX WITH GAS INLET
AND LIQUID FEED

A leaflet on "Quickfit"
Utility Assemblies
is readily available upon request

QUICKFIT & QUARTZ Ltd.

INTERCHANGEABLE LABORATORY
•
GLASSWARE

Dept. Z.Z., "Quickfit" Works,
Heart of STONE, Staffs.
Telephone : Stone 481

QUICKFIT

High Performance
VOLTAGE STABILISERS
and
REFERENCE TUBES

Close tolerance burning voltages
Wide range of operating temperature
Good stability over life
Freedom from output voltage "jumps"
Long operating life

NOW

ALSO AVAILABLE IN
SPECIAL QUALITY RANGE

The high performance of Mullard stabilisers has been improved even further by the introduction of *Special Quality* types, which will operate satisfactorily under rigorous conditions of shock and vibration. These special versions of normal production types combine extra-rugged construction with what has proved to be an inherently reliable principle of design, and they will be available in addition to the normal range.
Samples selected from every production batch of *Special Quality* tubes are tested against Services' specifications to withstand impacts of 500g and vibration of 6g at 175 c/s.
All three of the *Special Quality* tubes can be supplied with either pin or flying lead bases. Your enquiries for further details of these and other stabilisers in the Mullard range are welcomed at the address below.

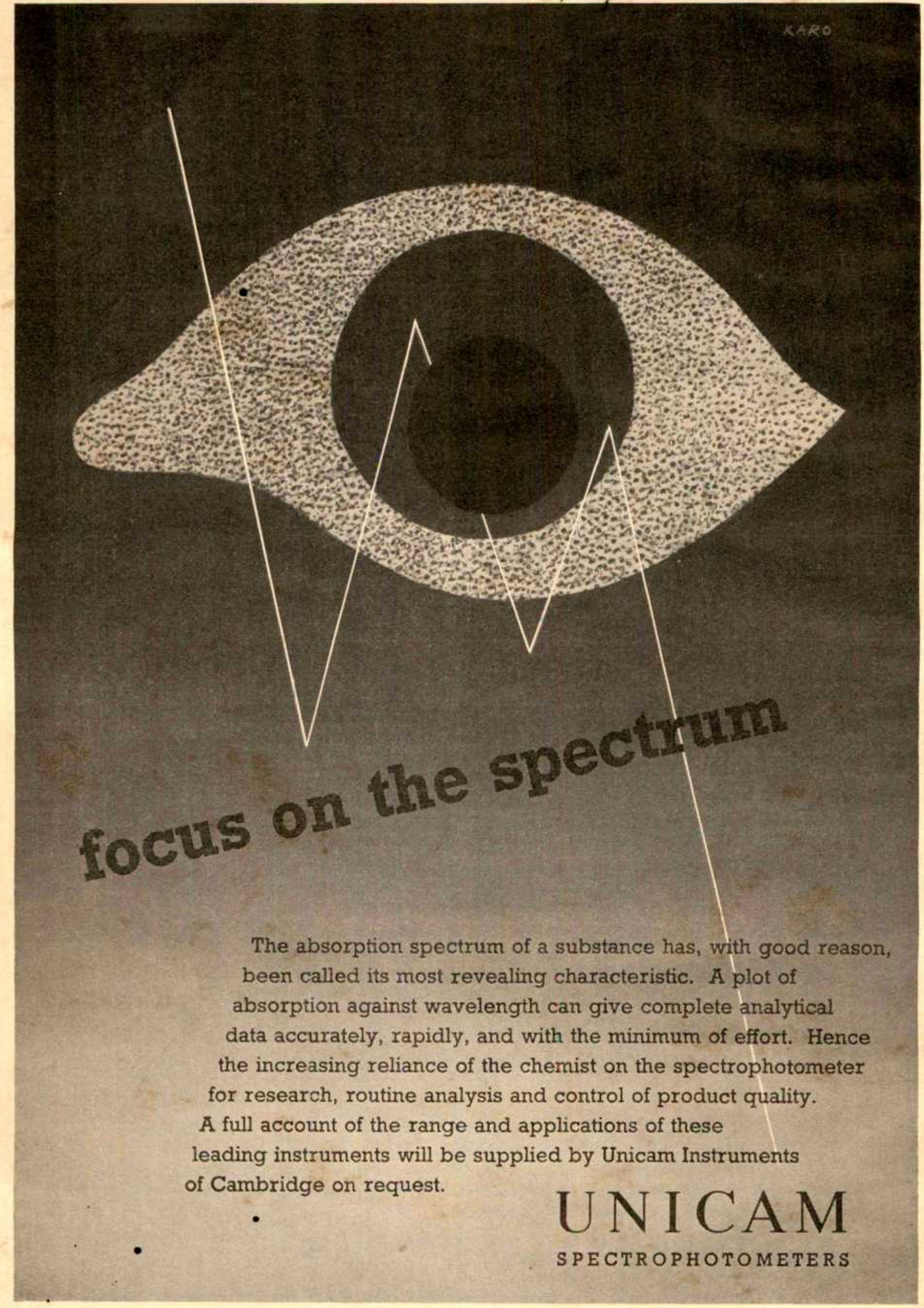
Special Quality Type No.		Electrical Equivalent		Burning Voltage (V)	Current Range (mA)	Maximum Ignition Voltage (V)
Pin Base	Flying lead Base	Mullard	British Services			
M8098	M8142	85A2	CV449	85	1 to 10	115
M8206	M8207	90C1	—	90	1 to 40	115
M8163	M8208	150B2	CV2225	150	5 to 15	180

Mullard
SPECIAL QUALITY VALVES

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MVT 170



The absorption spectrum of a substance has, with good reason, been called its most revealing characteristic. A plot of absorption against wavelength can give complete analytical data accurately, rapidly, and with the minimum of effort. Hence the increasing reliance of the chemist on the spectrophotometer for research, routine analysis and control of product quality. A full account of the range and applications of these leading instruments will be supplied by Unicam Instruments of Cambridge on request.

UNICAM
SPECTROPHOTOMETERS

U.137

NATURE

No. 4444 SATURDAY, JANUARY 1, 1955 Vol. 175

CONTENTS

Page
Atomic Energy for Peaceful Purposes . . . 1
A Classical Research on Plant Respiration. By Prof. Walter Stiles, F.R.S. . . . 3
Genetics and the Chromosomes. By Prof. C. D. Darlington, F.R.S. . . . 4
Chemical Microscopy. By Dr. N. H. Hartshorne . . . 5
National Museum of Victoria. By Dr. F. S. Wallis . . . 6
Scientific Centenaries in 1955. By Joan M. Eyles . . . 8
What is a Virus ? By Dr. Kenneth M. Smith, F.R.S. . . . 12
Kafuan Stone Artefacts in the Post-Australopithecine Breccia at Makapansgat. By C. K. Brain, Prof. C. Van Riet Lowe and Prof. R. A. Dart . . . 16

Obituary :

Prof. Enrico Fermi, For.Mem.R.S. By Prof. O. R. Frisch, O.B.E., F.R.S. . . . 18
News and Views . . . 19
Higher Technological Education in Great Britain . . . 22
Council of Scientific and Industrial Research, India . . . 23
Deep-Water Movements in the Ocean. By Prof. K. F. Bowden . . . 24
Laboratory Animals in the United States . . . 26
Professional Status of Management . . . 27
Welding in Ship Construction. By A. A. Wells . . . 28
New Zealand Department of Scientific and Industrial Research : Report for the Year 1953–54 . . . 29
Political Science as a University Subject. By Prof. T. S. Simey . . . 30
Effects of Radiation and Other Deleterious Agents on Embryonic Development . . . 31

Letters to the Editors :

Chromosomes of Monkeys and Men.—Prof. C. D. Darlington, F.R.S., and Ashraful Haque . . . 32
Delayed Toxicity of Radiostrontium in Monkeys.—G. M. Edington, J. M. Judd and Dr. A. H. Ward . . . 33
Action of Ionizing Radiations on Catalase in Presence of Cysteine, Cystine and Glutathione.—Dr. W. M. Dale and C. Russell . . . 33
Radiation Dosimetry of Rubidium-86.—E. W. Emery, J. E. S. Bradley and N. Veall . . . 34
Removal of Background in β-Sensitive Nuclear Emulsions.—T. Matitsch, Ch. Matiasek and Prof. B. Karlik . . . 35
Interaction of Two Constituents in Ferromagnetic Materials showing Reverse Thermo-remanent Magnetism.—Prof. T. Nagata and S. Uyeda . . . 35
An Attempt to observe Whistling Atmospherics near the Magnetic Equator.—Rev. J. R. Koster and L. R. O. Storey 36
Change of Elastic Constants in a Superconductor.—Dr. J. L. Olsen . . . 37
A Phase Diagram for 1 per cent Carbon-Iron Alloys containing up to 16 per cent Nickel.—P. Samuel, L. G. Finch and J. R. Rait . . . 37
Tidal Forces and the Formation of Hurricanes.—Charles L. Jordan ; Prof. Charles H. Smiley. . . . 38
Cytoplasmic Granules in Fibrogenic Cells.—S. Fitton Jackson . . . 39
Source of the *Phlei* Growth Factor for *Mycobacterium johnei*.—H. Williams Smith . . . 40
Effect of Vitamin A Deficiency on the Cerebro-spinal Fluid Pressure of the Chick.—Dr. D. H. M. Woollam and Dr. J. W. Millen . . . 41
Carotenogenesis in *Haematococcus pluvialis*.—M. R. Droop . . . 42
Saccharides of Different Varieties of Indian Rice.—D. B. Parihar . . . 42
Shikimic Acid in Grass.—A. Richardson and Dr. A. C. Hulme . . . 43
Effect of α-Naphthalene Acetic Acid on Yield of Indian Cotton.—Jayendra Bhatt and R. V. Date . . . 44
Distribution of *Pelmatohydra oligactis* (Pallas) in Scotland.—Dr. Monica Taylor . . . 45
Enhanced Light Absorption by Compounds in Chromatograms.—Prof. T. D. Price, Prof. P. B. Hudson and D. F. Ashman . . . 45
Adsorption of Glucose on a Weakly Basic Anion-Exchange Resin.—T. M. Reynolds . . . 46
Energy of Activation for the Acid-catalysed Hydrolysis of Esters.—V. R. Stimson . . . 47
A General Method of Aminomethylation.—R. O. Cinnéide . . . 47

CHAPMAN & HALL

Ready this month

IRRIGATION AND HYDRAULIC DESIGN

(Vol. I—General Principles of Hydraulic Design)

by

S. Leliavsky, PH.D., M.I.C.E., M.AM.SOC.C.E.

10″ × 7½″ 512 *pages* 314 *figures* 126*s. net*

THE TECHNOLOGY OF SOLVENTS AND PLASTICIZERS

by

Arthur K. Doolittle

(Assistant Director of Research, Carbide & Carbon Chemicals Co., U.S.A.)

9½″ × 6″ 1056 *pages* 463 *figures* 130 *tables* 148*s. net*

ASIA EAST BY SOUTH

A Cultural Geography

by

J. E. Spencer

(Professor of Geography, University of California)

11¼″ × 8½″ 453 *pages* 136 *illustrations* 68*s. net*

37 ESSEX STREET, LONDON, W.C.2

PRECISION BS INSTRUMENTS

Refractometers for Industry and Research

Our well-known standard Abbe type refractometer has a refractive index scale on glass and is read by transmitted light, thus leading to greater convenience in taking measurements and a higher degree of accuracy.

The instrument as illustrated is supplied with degree scale arc and micrometer screw reading directly to 10 seconds, corresponding to a refractive index accuracy within 0.00005. Conversion tables for use with sodium light are supplied.

DELIVERY FROM STOCK

Full particulars sent on application.

We shall be pleased to demonstrate these instruments and give any advice within our power, if you will call at our Works.

Bellingham & Stanley Ltd.

DEPT. N, 71 HORNSEY RISE, LONDON, N.19

PHONE: ARCHWAY 2270

ATOMIC ENERGY FOR PEACEFUL PURPOSES

LITTLE more than a year ago, on December 8, 1953, President Eisenhower first made his proposals for an international pool of atomic materials for peaceful purposes, and on September 25 the governments of the United States and of the Soviet Union disclosed the details of these proposals and of the unsuccessful efforts of the two countries to reach agreement on that plan. Progress has since been more marked than might have been expected, even although the published notes and memoranda exchanged between the two countries indicated the willingness of both countries to continue the negotiations. Agreement had then already been reached between the United States and six other nations to establish an international agency which would foster the growth and spread of the new atomic technology for peaceful purposes. Atomic materials were to be set aside for projects sponsored by the agency, and in due course the United States was to establish a reactor school to train representatives of friendly nations in the skills needed for their own atomic purposes.

At the end of September last, the United States delegate to the United Nations asked the steering committee to place on the agenda of the General Assembly as an important and urgent matter the United States proposals for the establishment of an international atomic energy agency for peaceful purposes. The Soviet Deputy Foreign Minister then suddenly announced his government's readiness to discuss the question in the General Assembly, though the discussions of the following two months have made it no clearer whether the U.S.S.R. is willing to participate in or support the international agency. Both Great Britain and the United States have given further weight to their proposals for promoting internationally the constructive use of atomic energy by their announcements that they are holding definite amounts of fissionable material for use in atomic research reactors abroad, and by their offer on November 5 to train foreign scientists as a first practical instalment of the Eisenhower plan for an 'atomic pool'. In this connexion Sir Pierson Dixon, the British delegate to the United Nations, stated specifically to the Political Committee of the Assembly that the British government could immediately offer a number of places in its four-week training course in the radioactive isotope school at the Atomic Energy Research Establishment at Harwell, and that other places might be made available at the Harwell School of Reactor Technology with courses lasting for periods of months.

It should be appreciated that, as Sir Winston Churchill told the House of Commons on November 16, Great Britain is at present the greatest exporter of radioactive isotopes in the world. Sir Pierson Dixon also told the Political Committee that it is Britain's intention to use the proposed agency to share our knowledge with other countries to the maximum extent permitted by security considerations and the demands for man-power and materials of our own projects. Moreover, the relaxation of restrictions on the exchange of information on atomic energy made possible by the Atomic Energy Act of 1954, both facilitates co-operation in the development of nuclear energy between the United States and other countries and further attests the sincerity of the American proposals to an extent which it is difficult for those outside the United States fully to appreciate.

In the course of the discussions at New York, the original American proposals were considerably modified. The draft resolution which the eight Western Powers specially interested in atomic energy sent to the Political Committee early in November noted the progress made in the negotiations between the eight Powers themselves—Great Britain, the United States, France, Canada, Australia, South Africa, Belgium and Portugal—for the establishment of an international agency, and recommended that they should continue. The resolution gave no lead, however, as to the functions, powers, organization, location, management, methods of voting or membership of the new body, and there was evidently no agreement among the sponsors themselves. Indeed, the United States Administration seems now to prefer bilateral arrangements with countries of its own choice for channelling technical knowledge and materials to the multilateral pool proposed by President Eisenhower. The international agency is thus left with functions little more than the preparation of bibliographies, the identification of scientific needs and resources, and the promotion of training facilities. In particular, this revised plan fails either to stimulate co-operation between East and West or to promote the use of nuclear experience and materials in the under-developed territories.

The resolution which was finally adopted unanimously by the Political Committee of the General Assembly on November 23, while not going into detail, referred specifically to the original objectives. It endorsed the negotiations now in progress, and expressed the hope that the international atomic agency will be established without delay, and that when the agency is established it will negotiate an appropriate form of agreement with the United Nations. The resolution recalls specifically, however, the initiative taken by the President of the United States on December 8, 1953, and international co-operation is recognized as important and urgent "in developing and expanding the peaceful uses of atomic energy to assist in lifting the burdens of hunger, poverty and disease". Moreover, the proposed international agency is "to facilitate the use by the entire world of atomic energy for peaceful purposes and to encourage international co-operation in the further development and practical application of atomic energy for the benefit of mankind".

The resolution also calls for an international technical conference of governments to be held under the auspices of the United Nations not later than August

1955, "to explore means of developing the peaceful uses of atomic energy through international co-operation and, in particular, to study the development of atomic power and to consider other technical areas such as biology, medicine, radiation protection and fundamental science—in which international co-operation might most effectively be accomplished". All members of the United Nations and the specialized agencies are to be invited to the proposed conference, and an advisory committee comprising representatives of Brazil, Canada, France, India, the Soviet Union, Great Britain and the United States was to be established to issue invitations to it, to prepare and circulate a detailed agenda, and to provide the staff and services required.

In organizing this conference, the Secretary-General of the United Nations, M. Hammarskjold, has already engaged as his special consultant Dr. Gunnar Randers, head of the Kjeller Institute of Atomic Research in Norway and director of the joint Dutch–Norwegian atomic research project. The conference, which is expected to meet towards the end of August in Geneva, is likely to be a serious scientific congress, and its purpose will be not the exchange of views so much as to tackle the practical technical and economic problems involved, for example, in the generation of power from nuclear energy in various parts of the world, and particularly in under-developed areas. The advisory committee named in the Assembly's resolution is expected to meet this month.

All this represents a highly satisfactory outcome of the United Nations debate on atomic energy. The main Russian objections have been either met or withdrawn, and whether or not the U.S.S.R. participates, it has been well worth while that Britain and the United States should demonstrate their intention of going forward in collaboration with any nations willing to do so. It has shown the whole world that the major Western governments are prepared to lift some of their secrecy restrictions, and to take the initiative in helping others; and in particular it shows the industrially less advanced nations that they will not be denied the benefits of nuclear energy, however acute may be the limitations of their industrial and financial resources.

If, however, nuclear energy has thus been placed fairly in the context of industrial development and human welfare, in contrast to that of warfare and destruction, it is important that excessive expectations as to the rate of progress should not be aroused. When the international agency is ready to act as a clearing-house for information and assistance, its major task will be to ensure a clear public understanding of the limitations as well as the possibilities of nuclear power and the production and applications of fission products, including radiochemicals. Even in the United States, there is little chance of any important nuclear power production for another ten years, and it will then be a complementary source of energy rather than supplementing coal and oil in meeting the demand for electric power. Its principal effect in the United States is likely to be to prevent power costs rising because of higher fuel costs. In Great Britain it is hoped to have a nuclear reactor producing electricity commercially by 1958. It must therefore be made clear at the outset that, even for nations with the most advanced technical developments in this field, substantial contributions to industrial power from this source are unlikely within the next decade. Undue optimism in Africa or Asia, for example, might engender disappointment or suspicions which would hinder co-operation. This is one point at which scientists, both individually and collectively, through such bodies as the Atomic Scientists Association, and particularly the Science Co-operation Centres of the United Nations Educational, Scientific and Cultural Organization, may be able to assist. By turning discussion from questions such as the morality of atomic warfare to the constructive consideration and public understanding of the practical conditions for co-operation in the development of nuclear energy for peaceful purposes, or the application of fission products in medicine, agriculture and elsewhere, not only will the possibility of misunderstanding or frustration be minimized, but also the conditions promoted in which international agreement in relation to disarmament generally might be reached.

There is a further reason why the proposals for co-operation in the development of nuclear energy for peaceful purposes concern scientists in general. Any step which reduces the area of secrecy in regard to scientific and technical knowledge will be welcomed in principle by scientific men. The present proposal promises also to affect the costs of energy and the availability of raw materials as well as of fissionable material in various countries. The whole history of science shows that the exchange of scientific and technical knowledge is seldom in one direction for long. Britain may be at present the world's largest exporter of radiochemicals, but it is probable that before long she will be receiving from the European Agency for Nuclear Research at Geneva as well as contributing to it.

Before that stage can be reached, however, and especially in regard to the under-developed areas, there are certain conditions of scientific and technical development to be achieved; and it is important that these should be clearly understood. It is of little use, for example, for Britain to be able to supply radioisotopes to the hospitals of the Middle East, South-East Asia or Central Africa if the technicians are not on the spot to use such materials properly, or if the necessary equipment—which is expensive—is not available. Neither the technicians nor the equipment can be supplied without forethought. Staffs have to be found and trained, and if that training is given overseas, there is the question of cost.

Not all the territories which might benefit from such supplies and techniques can easily provide either the candidates for training or the finance to support and to equip suitably the institutions in which they will work when trained. Not all are yet ready to divert resources to such purposes, and still more does this apply to the production of nuclear power. The provision of the necessary technical knowledge and trained technicians in under-developed areas, where nuclear power could contribute to industrial development and the raising of standards of living, will by itself do nothing to solve the economic and financial problems involved in the construction of the reactors and other plant required Such problems will be encountered even if technical help is limited to those under-developed areas where nuclear energy promises to be the most economical source of power Besides technical aid in the narrower sense, and probably—at least at the start—some overseas technical experts, such countries need the political maturity which can create the conditions likely to attract such experts, and also the substantial capital required to finance the developments and to set in train a well-balanced and intelligently applied economic programme Much more is implied than a programme of scientific and technical co-operation, or of education in the scientific and technical sense

Moreover, if the administration in under-developed countries is to be given a chance to raise its standards, too great care cannot be taken to avoid minor causes of misunderstanding and prejudice Even in Great Britain, the Atomic Energy Authority has encountered difficulties, for example, in the disposal of wastes, through public ignorance and prejudice In more backward countries, the consequences of mistakes arising through moving too fast and in advance, for example, of an adequate supply of those competent to handle radiochemicals safely, might well prejudice fatally the efforts of a local administration to establish the favourable conditions for economic development

The British and the American governments have indeed given a welcome lead, and the direct and indirect possibilities of the proposals approved by the United Nations General Assembly cannot be over-stressed If they are to be realized, much patient constructive effort will be required, and not least by scientists themselves On them must rest no small share of responsibility for the success of the international scientific conference to be called next summer Beyond that they could do something to promote the educational work which is required to promote a full public understanding of what is involved in co-operation in the development of nuclear energy, and the price that is demanded in self-discipline even in its utilization for peaceful purposes

The repeated questions in the House of Commons as to the effect of atomic explosions on the weather testifies to the need for that educational work, even in the Western countries That influence has been consistently denied by meteorologists , nevertheless it forms the subject of a short communication to the Paris Academy of Sciences (November 15) by C -M Martin The danger of test explosions of nuclear weapons causing a permanent change in terrestrial radioactivity was admitted by Prof A Haddow in addressing the Parliamentary Association for World Government at a meeting in the House of Commons on December 8, and Prof Haddow made two useful suggestions First, he advocated an international meeting of scientists on an unofficial level, much on the lines which Prof Lewis Mumford suggested last year to the American Philosophical Society, to discuss the implications of atomic warfare , and second, the founding of a permanent body forming a link between the political world and the United Nations and the world of science The clear establishment of the facts and then making them widely known in some such way are at least safeguards against irrational prejudice suddenly forcing unilateral action which might endanger the public interest There can indeed be few fields where the co-operation of men of science is more essential in promoting the public understanding upon which wise policy and effective international co-operation must be based than in that of nuclear energy, its development, its application and its control

A CLASSICAL RESEARCH ON PLANT RESPIRATION

Analytic Studies in Plant Respiration

By the late F F Blackman Pp x+232 (Cambridge At the University Press, 1954) 40*s* net

UNDER the direction of the late F F Blackman some thirty-four years ago, the output of carbon dioxide by each of twenty-one Bramley's Seedling apples, in atmospheres of a variety of compositions, was followed over various periods of time These atmospheres included normal air, pure nitrogen, pure oxygen and mixtures of oxygen and nitrogen in which the concentration of the former was less than in normal air. A feature of all the experiments was a transference of the apple under investigation from one atmosphere to another of different composition The results of this research, in so far as it concerned apples which for part of the experimental period had been kept in an atmosphere of nitrogen, were afterwards published as three papers in the *Proceedings of the Royal Society* during 1928 It was in the third of these papers that Blackman, from his masterly analysis of the experimental data, put forward his theory of oxidative anabolism

Although the experimental data dealing with carbon dioxide output in environments possessing low oxygen concentrations were touched on in that paper, and although the records of all the experiments were brought together as an appendix to the second paper, a detailed analysis of the experimental data was never published by Blackman He had, nevertheless, spent much time and thought on the matter, and he had, indeed, prepared a series of papers in which the data were subjected to an analysis as exhaustive and masterly as that exhibited in the papers already published on carbon dioxide output in air and in nitrogen The present volume contains these papers, six in number, previously unpublished, together with a reprint of the three published in 1928 , it thus contains a complete account of the experiments of 1920–21 with Blackman's analysis of the data and the metabolic concepts he derived as a result of this

In reading these papers, one cannot fail to be impressed by the amount Blackman was able to derive from the experimental data It must be realized that, when the experimental work was undertaken, next to nothing was known of the effect of varying oxygen concentration on respiration , indeed, even now our knowledge of this is very limited From the data of carbon dioxide output alone, Blackman was able to separate the fermentation and respiration components of the total carbon dioxide output in low oxygen concentrations and to show convincingly that, as the fermentation component fell and the respiration component rose with increasing oxygen concentration, the carbon dioxide of respiration replacing that of fermentation bore a constant relation to the drop in fermentation up to the extinction point, that is, the lowest oxygen concentration in which fermentation fails entirely His analysis further led Blackman to the conclusion that oxygen plays a threefold part in respiration. In addition to its oxidation function resulting in the production of carbon dioxide, and its anabolic function in oxidative anabolism, Blackman came to the conclusion that oxygen serves as an activator of the rate of conversion of inactive carbohydrate to the activated carbon compound which forms the starting-point of fermentation, and from which the substance forming the starting-point of respiration, if not identical with it, is derived.

In assessing the value of Blackman's work on respiration, it is necessary to bear in mind two things One of these is the time at which the work was done The papers now published for the first time are dated from 1935 to 1937, when views now current on the fermentation and respiration mechanisms were still only in an early stage of their formulation The second point, and this is all-important, is that Blackman's approach to the problems of respiration was that of a physiologist and not that of the biochemist He wrote (p 127) " we stress that our objective is to generalize the metabolism into classes of reactions and the biological control of their rates. This we take to be the proper objective of physiology as segregated from biochemistry which seeks to individualize the reactants and the products of intermediate metabolism". The reader of these papers can be in no doubt that in them Blackman's objective was achieved

Thirty-four years is a long time in the history of modern plant physiology It may well be asked why so long a period has elapsed between the winning of the experimental data and the publication of the full conclusions derived from them The answer is no doubt to be found in Blackman's desire for perfection It seems likely that he was still not satisfied with some, at any rate, of the papers now published for the first time. There are few of us who would not have been satisfied with very much less Plant physiologists should be grateful that this record of work of the leading British plant physiologist of a century should have been made generally available

WALTER STILES

GENETICS AND THE CHROMOSOMES

Animal Cytology and Evolution

By M J D. White Second edition Pp xiv+454. (Cambridge At the University Press, 1954.) 45s. net

IN all sexually-reproducing plants and animals the reproductive cycle depends on an alternation of two changes in the nucleus an addition at fertilization, and a reduction at meiosis. Fertilization is simple, but meiosis is complicated It consists, however, in a chain of events which almost universally shows a certain causal sequence, thus (1) crossing-over is a condition of chiasma-formation, (2) chiasma-formation is a condition of metaphase pairing, (3) metaphase pairing is a condition of segregation and hence of reduction, (4) reduction is a condition of continuing sexual reproduction.

A most important object of the genetic study of chromosomes in recent years has naturally been to find out the meaning of these rules It has appeared, for example, that the exceptions are confined to one sex, the heterozygous sex, in certain groups of dioecious animals The rules always hold for the other sex Hence, crossing-over is (at least) co-extensive with sexual reproduction, which is therefore invariably a mechanism of gene recombination within a group of organisms Thus the cellular sequence of events crosses a population sequence of events and from this intersection arises a general chiasma theory, according to which a sexual species is a group of organisms enjoying gene recombination, while a chromosome is a group of genes capable of such recombination

In the past twenty-five years the uniformity of plants has confirmed these principles, while the diversity of animals has directed attention to their exceptions, exceptions which illustrate the physiological control and evolution of the chromosome mechanism itself For the development or limitation or re-interpretation of these ideas we naturally turn to an evolutionary account of the chromosomes in animals

The first edition of this book by Dr M J D White was handicapped by the difficulty of separating animals from plants The exceptions could not be related to the rules Nevertheless, both were described and the fundamentals were correct How does the second edition compare with it ? The great fundamental is, of course, crossing-over The treatment of this question may be taken as representative of Dr. White's methods and point of view

It was Janssens who in 1924 made the first important chromosome contribution to the theory and based it on the study of grasshopper chromosomes According to White (p 83), Janssens assumed that "each chiasma is a place where two out of the four chromatids . have undergone crossing over" This is the current theory of crossing-over But it was not Janssens's theory nor did White's first edition say so Janssens assumed that at any chiasma 0, 2 or 4 chromatids might have crossed over earlier , and two of them might cross over later

Janssens's theory was too complex and too permissive to be disproved Not so his observations. Certain of them remain unsurpassed and undisproved He described (*l c*, p 178) and illustrated "l'absence de stade pachytène" in the grasshopper *Mecostethus grossus* A restriction of pairing to one end of each chromosome led to a restriction of chiasma-formation and crossing-over to this end This highly significant observation has since been confirmed by observations in plants and animals which underlie the current theory of meiosis But White (p 98) claims the support of Janssens for an exactly opposite account of the species "there is direct observational evidence that pairing is complete at pachytene"

Assisted by this misreading of Janssens, White maintains a theory of the mechanism of crossing-over which he had advanced in his first edition. It is that "chiasma localisation is intimately connected with the alternation of heterochromatic and euchromatic segments" (p 98), or the distribution of euchromatin and heterochromatin is "largely responsible for determining the distribution of crossing over along the length of the chromosome" (p 373) A little while before White advanced this view it had, however, been disproved by studies on plants carried out in order to test such an obvious possibility For example, in *Fritillaria* there are species with and without heterochromatin but both groups include species with localization and without localization of chiasmata In *Paris* also there are species with and without heterochromatin but both kinds have localization of chiasmata In both genera all localization is near the centromere but in *Fritillaria* the heterochromatin is near the centromere, in *Paris* it is away from the centromere Nature apparently has in every circumstance misunderstood the theory

Dr White does not refer to the prior disproof of his views or to the relevant papers He merely wipes out the whole field of inquiry He points out that studies showing heterochromatin in plants by means of nucleic acid starvation are "suspect" and their description merely "picturesque terminology" On the other hand, studies showing the absence of heterochromatin in plants merely arise from "inadequate technique" and "insufficient evidence" The conclusions of those who have pursued this question are "untrue" (p 373), and the critical citation is removed from this edition

In general, Dr White has attempted to cut out and throw away the theories he accepted in his first edition But his treatment has been careless and the result is inconsistent The theory, an evolutionary theory, of pairing segments and differential segments in sex chromosomes was originally derived from the general chiasma theory At one stage Dr White accepts it (p 285) But elsewhere he dismisses the interpretation on which it rests in *Drosophila* as "impossible" (p 223) and in mammals as a "vue de l'esprit" (p 286) Dr. White's application of this theory (which he illustrated as Fig. 84 in his first edition) was, I agree, impossible. But that was because he had copied it incorrectly from the original author He has now cut it out

Again, Dr White rejects the view that parthenogenesis is an escape from sterility "there is no reason to believe that it applies to animals at all" (p 340) But three pages later he adopts the rejected view parthenogenesis avoids the results of unsuccessful meiosis, "we consequently find that a number of species and races of parthenogenetic animals are polyploid " (p 343)

Dr White too often omits to cite the publications he is contradicting and too often also he seems to have forgotten the evidence he is contradicting even when it appeared in his first edition For example, when he asserts that the centromere can be broken and is not therefore "a special kind of gene" (p 26), one supposes that he has forgotten that the theory of the centromere as a group of genes was derived from observations of its breakage When he says that in a bivalent with a single chiasma "obviously the terms *reductional* and *equational*, as applied to the two meiotic divisions have lost all genetic meaning" (p 232) one supposes that he has forgotten that this principle provides us with the means of mapping the chromosomes of the lower organisms. But when he states (p 381) that "structural rearrangements" in chromosomes are of no importance in the origin of species and the hypothesis "is now seldom mentioned", can one suppose that he has forgotten all the evidence, old and new alike ?

Above all, as Dr White nearly stumbles on the principle of the evolution of genetic systems, one wonders whether he has noticed the idea that all chromosome behaviour is subject to physiological control which, being also genotypic, is subject to selection and adaptation But, alas ! These words are not in Dr White's index The problems behind them raise no difficulties for him Their solution has made no impression on him He writes, therefore, not of evolution as we now understand it, but of comparative anatomy The difficulties with which we find him struggling are merely due to his being out of his depth when he writes about chromosomes and evolution

C D DARLINGTON

CHEMICAL MICROSCOPY

Microscopy for Chemists

By Prof Harold F. Schaeffer Pp viii+264 (New York D Van Nostrand Company, Inc , London Macmillan and Co , Ltd , 1953) 34*s* net

ANY attempt to overcome the reluctance of the average chemist to take advantage of the many useful applications of the optical microscope in chemical practice deserves encouragement, and for that reason this introduction to chemical microscopy is to be welcomed. The author has dealt with most of the important aspects of the subject in a clear and concise manner, and while pointing out that it is best studied under the personal guidance of a competent instructor, he has endeavoured to present his material in such a way as to be intelligible to the worker who must depend on his own resources. Doubtless with the needs of such lone students especially in mind, he has given in the last ninety pages of the book a series of illustrative experiments with full explanatory notes and instructions It is good to see that a description of the Kofler hot stage is included, though it is a pity that a little more space could not have been found in which to deal more fully with some uses of this valuable accessory which only receive bare mention, such as, for example, the elegant contact method for studying phase relationships in binary systems

The least successful part of the book is the chapter dealing with polarized light Admittedly the author states that an adequate treatment of optical crystallography lies beyond the scope of the book, but some parts of this section are quite misleading Not only are there several errors of fact, but also the treatment fails to make clear that the optical properties of anisotropic crystals are directional in character, and that what is observed under the microscope depends on the particular optical section which a crystal presents and, in lesser degree, on its thickness It is true that there is some mention of optic axes near the end of the chapter, but by the time the reader reaches this point, the damage will have been done. Extinction behaviour is discussed without any reference to the morphological properties of crystals (except by implication), and parallel extinction is incorrectly given as a property possessed solely by uniaxial crystals. The diagram on p 111, which seems to be intended to show the changes in a typical biaxial interference figure on rotating the stage (though the type of figure is not specifically stated), is quite wrong It gives a uniaxial cross and ring as the appearance of the figure in the extinction position, while the isogyres are referred to as parabolas and are shown as moving in and out bodily, that is, not pivoting about the melatopes Again, in distinguishing between uniaxial and biaxial crystals, the statements are made that a uniaxial crystal has two refractive indices and a biaxial crystal three, without making clear that these are the principal refractive indices and that they are not (with the exception of ω) necessarily presented by a random section, and that certainly no biaxial section presents three indices as the beginner might infer

When dealing with that part of chemical microscopy which may perhaps be described as ordinary chemistry in miniature, the author is on firm ground, and the treatment is all that could be desired So too is that in the introductory chapters on the principles, construction and use of the compound microscope and its accessories The book is on the whole well produced, though consideration might be given in any future edition to improving the clarity of some of the photomicrographs of typical crystalline precipitates Except for those parts criticized above, the book is a useful addition to the literature of chemical microscopy, particularly for the beginner

N H Hartshorne

NATIONAL MUSEUM OF VICTORIA

Collections of a Century

The History of the First Hundred Years of the National Museum of Victoria By R T M Pescott Pp xii+186+18 plates (Melbourne National Museum of Victoria, 1954) 30*s* (Australian)

It is proper that museums, in common with other traditional institutions, should pause at intervals and examine critically their past achievements, and from their failures or successes formulate their policies for the future in accordance with past experience The present volume is a painstaking compilation by the director, Mr R T M Pescott, of the history of the first hundred years of the National Museum of Victoria Dedicated to the memory of that great geologist, Frederick McCoy, the book forms a permanent record of the Museum It also contains such pertinent remarks and observations that it has much of value for the whole museum profession and indeed for all those interested in museums In an apt foreword, Sir Russell Grimwade, chairman of the trustees, stresses the especial responsibility of Australians to preserve a knowledge of the past in a country which, at any rate in its natural history aspects, has seen so many violent changes in the historical past

In common with many museums, the National Museum of Victoria owes its origin to a local philosophical society and individually to an English army officer, Captain Andrew Clarke R E, who had the vision of a comprehensive museum in the colony of Victoria Incidentally, it was he who gave it the right type of initial policy and insisted that its main function was to instruct rather than bewilder with a confused jumble of curiosities In 1854 McCoy accepted the position of professor of natural science in the University of Melbourne and in 1858 was appointed director of the Museum He remained in this position until his death in 1899 At the outset, he clearly differentiated between university museums, which exist for internal teaching purposes, and national museums, which contain material of national value for the instruction and recreation of the community By means of wise purchases and other acquisitions McCoy amassed material and the present comprehensive state of the natural history collections owes much to his foresight and vision For example, the original description of the gorilla did not appear in print until 1847, when a skull only was included, yet by 1863 McCoy actually had specimens of these animals on display in his Museum Of outstanding importance was the purchase in 1863 of the famous John Curtis collection of insects with many types, both British and foreign, offered, strangely enough, by Dr J E Gray, of the British Museum

In 1870 eighteen trustees were appointed to control the Museum, and McCoy had a particularly difficult time in obtaining funds He complained of frustration in the execution of his plans, and it is to his credit and indomitable courage that he carried on with the Museum and eventually completed forty-three years of service, collecting some 510,000 specimens valued at more than £40,000.

After the death of McCoy, the Government of the State of Victoria turned naturally for advice on the future policy of the Museum to Prof (later Sir) Baldwin Spencer, who had been appointed to the chair of biology in the University of Melbourne in 1887 He was appointed honorary director, and the Museum was moved from the precincts of the University to the Public Library buildings The first result of the new policy was the inclusion of anthropology in addition to the sections of natural history, and secondly, the arrangement of the collections on an evolutionary rather than a geographical basis Spencer resigned in 1928 in order to write up his earlier, and conduct new, researches, but in 1929 he died of a sudden heart attack

James Kershaw, previously curator, was appointed director after the Museum had been served by two honorary directors (McCoy and Spencer) for a period of seventy-five years—surely a unique record. Kershaw brought to his new position a wealth of experience in the service of the institution Since 1925 the Museum had unfortunately experienced a decline in public interest, and one of Kershaw's first acts was to introduce dioramas and habitat groups—the first to be seen in Australia He also planned a special aboriginal art exhibition In 1931 Kershaw severed his official connexion with the Museum—closing a record of more than seventy years continuous service of father and son—and Mr D J Mahoney was appointed director Mahoney placed an emphasis on the function of research in museums and immediately set about the reorganization of the *Memoirs of the National Museum* He also advised the strengthening of the small staff by the appointment of honorary workers

It was in 1944 that the present director was appointed, and during the ten years he has been in office it is evident that he has devoted much attention to the educational aspects of the Museum He has already laid down how an educational objective could be achieved in a new building on a site which was reserved in 1948

This well-produced volume closes with a chronological history of the institution and a list of the present trustees and staff It is no dull monotonous historical record but a vivid—in some cases day-by-day—recital of the activities of a live institution Moreover, it contains much that will serve as an inspiration to Mr Pescott's museum colleagues throughout the world

F S Wallis

History of the Primates

An Introduction to the Study of Fossil Man By Prof W E Le Gros Clark Fourth edition. Pp. 6+119 (London British Museum (Natural History), 1954.) 4s

PROF W E LE GROS CLARK is indeed a master in his subject, and the fourth edition of his "History of the Primates", printed for the trustees of the British Museum (Natural History), contains the latest ideas on this problem put in a way that the non-specialist can appreciate Of recent years, much new evidence has accumulated The discovery in Kenya of primitive apes of Miocene age (very possibly the basal 'stuff' from which has evolved both the line of man and of the anthropoid apes) and the finding by Prof R A Dart and Dr R Broom in South Africa of the early Pleistocene Australopithecinae (ape-men not yet classed as human by the author, Prof Le Gros Clark, until evidence turns up to show that they were talkers and tool makers) have completely revolutionized previous ideas on the subject

The Piltdown hoax is treated firmly, if discreetly, and, of course, the Galley Hill skull is dismissed as being of a relatively recent date He also dismisses as unproved the great antiquity of the Kanam and Kanjera finds in Kenya The fact that new test methods have been discovered, which would make another such hoax as that of Piltdown impossible, is pointed out, these new methods, some chemical such as the fluorine test and others physical such as the carbon-14 method of dating, are extremely valuable aids for study quite apart from the question of detecting frauds

Prof Le Gros Clark concludes his book with a timely warning "If Man has gained his intellectual dominance over his fellow creatures by concentrating his evolutionary energies on the development of his brain, it remains to be seen whether he can now maintain his position by contriving a method of living in orderly relations with members of his own species If he fails to do so he may yet follow the example of many other groups of animals which have achieved a temporary ascendancy by an exaggerated development of some particular structural mechanism He may become extinct" M C BURKITT

Bernstein Polynomials

By Prof G G Lorentz (Mathematical Expositions, No 8) Pp x+130 (Toronto University of Toronto Press, London Oxford University Press, 1953.) 45s net

THIS book consists of four chapters In the first, properties of Bernstein polynomials in the real domain are developed, beginning with the proof of the approximation theorem of Weierstrass The close connexion with the theory of probability is emphasized, and some of the results, relating to monotone or convex functions or functions of bounded variation, are due to the author and have previously only appeared in the Russian journal *Mat Sbornik*

In the second chapter Bernstein polynomials are generalized and applied to the approximation of discontinuous functions of general type (integrable or measurable) The connexion with moment problems and the theory of summation is discussed, and the approximation of $f(x)$ by linear sums of powers x^{α_ν}, where $\alpha_0, \alpha_1, \ldots, \alpha_\nu,$ is a sequence such that $\Sigma\alpha_\nu^{-1}$ is divergent is studied In Chapter 3 contact is made with abstract analysis It begins with a discussion of Banach spaces and functionals, and then moment problems (with Stieltjes integrals) are considered Other topics treated are rearrangements of functions, spaces of functions and Hausdorff methods of summation The last chapter deals with the theory of Bernstein polynomials in the complex domain, and this ends with the consideration of degenerate polynomials and the connexion with the summation of power series

The author has a clear style, even if a little concentrated in places, and has covered a great deal of material in the space available The printing is excellent, as is usual with the University of Toronto Press L S GODDARD

Molecular Structure and Related Problems

Edited by Y Asami and Prof K Higasi (Monograph Series of the Research Institute of Applied Electricity, No 4 (1954)) Pp vii+140 (Sapporo Research Institute of Applied Electricity, Hokkaido University, 1954, Oxford Basil Blackwell) 25s

PROFS Y. ASAMI and K Higasi have gathered together a group of nine papers, most of which represent work in molecular structure associated with their two departments at Hokkaido University in northern Japan These articles, several of which are in the nature of reviews, were read at a symposium in Hokkaido in November 1953 They show how great is the development of theoretical and experimental chemistry in Japan

As would be expected from a country where the tropolone system was first discovered, several of the articles deal with π-electron problems But dipole moments, the hydrogen bond, the activated complex in chemical reactions, the dispersion of ultrasonic waves, paramagnetic resonance and intermolecular potentials are also included The standard of publication and printing is high The English language used is beyond reproach

Mechanics of Materials

By Prof. E P Popov. (Prentice-Hall Civil Engineering and Engineering Mechanics Series) Pp. xiv+441. (New York Prentice-Hall, Inc, 1952, London Macdonald and Co (Publishers), Ltd, 1953) 70s net

PROF E P POPOV has added another to the list of excellent text-books which are available on elementary strength of materials His object is to present the engineering undergraduate with a clear exposition of the fundamental principles of the subject He does this admirably and has evidently put much thought into the order, as well as the nature, of the topics considered

The sixteen chapters adequately cover most of the material that is usually presented in Britain under the title of 'strength of materials', as distinct from 'theory of structures' This book differs from comparable works in certain respects For example, it contains a treatment of torsion of thin-walled hollow members which is very welcome Again, the method of virtual work is presented instead of Castigliano's theorem for the solution of problems by the energy method, certainly, much can be said for the virtual work approach

The text contains plenty of examples, both worked and unworked (with answers) These problems are a main feature of the book and considerably increase its value It is unfortunate that the price of the book is so high, because it may prevent many engineering undergraduates from possessing this excellent work

SCIENTIFIC CENTENARIES IN 1955

By JOAN M EYLES

IT is a view generally held to-day, supported by vital statistics of the past two hundred years, that we tend to live longer than our forefathers That being so, the ages of five men who were in their day distinguished scientists, and a sixth who is better known as a historian, all of whom died in 1555, seem worthy of special notice , for only one of them died before the age of sixty, while another reached seventy-seven, and the historian achieved the then remarkable age of eighty-five . One wonders whether a similar group of academic men of the present century could provide a better average Yet it cannot be claimed that these men had any special advantage over their fellows One was the son of a poor workman, another had a long struggle against adversity in his early years, and most of them travelled in Europe at a time when, although some of the epidemic diseases of the Middle Ages had nearly disappeared, the ravages of plague were particularly severe in Italy, France and Germany, and typhus fever, in one form or another, was frequently epidemic

The historian was Polydore Vergil, an Italian born about 1470 in Urbino, who passed about fifty years of his life in England He deserves attention here because he was the author of the first history of inventions, his "De Inventoribus Rerum" (About the Inventors of Things), a book which appeared first in 1499 and went into something like a hundred editions, in at least seven different languages He also wrote a book on prodigies, in which he endeavoured to show that most of the prodigies he quoted could be explained on rational grounds, and those that could not be thus explained did not exist. Polydore arrived in England in 1502 as a sub-collector of Peter's Pence, and at the age of eighty he received permission to return to Italy, where he died on April 18, 1555[1] His book of inventions continued to flourish and editions appeared even in the eighteenth century He gathered his information from the Bible, the classics, and many medieval sources, and although his book is now no more than a curiosity, he can be regarded as one of the earliest to study the history of science

Not many scientific authors of the sixteenth century have had one of their principal works printed twice in the past fifty years, but this is true of Georg Bauer (1494–1555), better known by the Latinized version of his surname, Agricola, whose beautifully illustrated work on mining and metallurgy "De Re Metallica" was translated by Herbert Hoover (later President of the United States) and his wife in 1912 The woodcuts have often been reproduced, and the Hoover translation was recently reprinted. Agricola was born at Glauchau in Saxony and after studying at the University of Leipzig for two years he took a post teaching Greek and Latin at Zwickau His interests then seem to have turned towards medicine and science, and after further study, including two years in Italy, he obtained a medical degree, and in 1527 a post as doctor in the new mining town of Joachimsthal, in Bohemia Here he began to make a close study of mining methods and in 1530 published his first mineralogical work, entitled "Bermannus", written in the form of a conversation between two learned physicians and a third man, Bermannus, versed in mining lore. Soon after, Agricola left Joachimsthal and in 1533 settled in Chemnitz, a Saxon town where he was resident until his death, and where, while following his profession, he continued to study mining and metallurgy He died on November 21, 1555 , but his "De Re Metallica" was not published until the following year, the delay being occasioned, it is said, by the preparation of the numerous woodcuts It remained a standard work for nearly two centuries, and is to-day a source-book of outstanding importance

An English physician who claimed friendship with Agricola was Edward Wotton, born in Oxford in 1492 He became a Fellow of Magdalen College, Oxford, in 1516 and in 1523 went to Italy for three years, studying medicine at Padua , it was probably during this period that he met Agricola After Wotton's return to Britain he became a member of the College of Physicians and was its president during 1541–43 Later, he published a zoological work, "De Differentiis Animalium" (Paris, 1552) which, while largely a compilation from ancient authors, has been called the first systematic work in zoology Wotton died in London on October 5, 1555

Yet another medical man who died in 1555 was Jacques Dubois, also known by the Latinized version of his name, Jacobus Sylvius Born at Amiens in 1478, the son of a poor workman, he eventually became one of the leading anatomists in Paris He was a popular lecturer and attracted many students, including Vesalius and Servetus. Sylvius made many additions to anatomical nomenclature, but his merits are apt to be forgotten because Vesalius criticized his teaching Nevertheless, it was Sylvius who invited the humble barber-surgeon Ambroise Paré to dinner and discussed the latter's novel treatment of gunshot wounds, an encounter which seems to have led to the publication of Paré's first book , for later Paré wrote "Which things when I told him, the good old man requested me to publish in print my opinion concerning these things" Sylvius died on January 13, 1555, five years after he had been appointed professor of medicine in the Collège Royal.

The College Royal, later the Collège de France, was founded by Francis I in 1529, and began with two professors in Greek and Hebrew, but was rapidly extended to include chairs in medicine, mathematics and other subjects The first holder of the chair of mathematics was Oronce Fine, who was appointed in 1531. Born at Briançon in 1494, Fine's early life was a long struggle against poverty He taught mathematics in Paris, but was obliged to make and sell instruments to supplement his income, and he made a famous clock for John, Cardinal of Lorraine In 1517 he went to prison, apparently for opposing, with other professors and students, the Concordat made by Francis I with Leo X He was released in 1524 Fine was also a cartographer of note, and published a four-sheet map of France in 1538 He died in Paris on October 6, 1555

Another cartographer and mathematician who died in the same year, although much younger at the time, was Regnier Gemma Frisius (1508–55), born at Dokkum in Friesland. When a medical student at Louvain he was a friend of Vesalius, whom he assisted to rob a gallows outside the town walls, in order to further their medical studies Although

Gemma became professor of medicine at Louvain, and never left that University, his real interests lay in the realm of mathematics, and he gave private lectures in the subject, one of his pupils being Mercator Gemma was the first to suggest the method of finding the longitude by the difference of times, although the unreliability of early portable clocks made it impossible to carry out the idea until John Harrison constructed a successful chronometer two centuries later He was also the first to describe the method of elementary triangulation, illustrating his theory with an account of an actual survey, using Antwerp Cathedral as his first station. This account appeared as an appendix to Apian's "Cosmographia" in 1533[2] Gemma died when only forty-six, on May 25, 1555, and in the year of his death revealed his advanced outlook by writing a letter in which he praised the new Copernican theory He certainly deserves an important place in the history of cartography

Yet another mathematical cartographer of the period was Giovanni Antonio Magini, born at Padua in 1555, a competent astronomer and a friend of Tycho Brahe He produced a large map of Italy in 1608 and his atlas of Italy was published after his death by his son In 1617 he died of apoplexy at Bologna, where he had held the chair of mathematics since 1588

A surveyor of a somewhat different category was Richard Carew, of East Anthony in Cornwall, born on July 17, 1555, who published a "Survey of Cornwall" in 1602 Carew was a country gentleman and something of a poet, and was chosen when a lad of fourteen at Christchurch, Oxford, to debate extempore with Sir Philip Sidney, his elder by a year, before an audience of noblemen He was a member of the first Society of Antiquaries, and his Survey is a very readable account of sixteenth-century Cornwall, with many interesting details concerning the tin mines and the fishing industry Carew himself took great pleasure in a fishpond he had constructed and praised it in verse " . My fishful pond is my delight" He died in 1620

Two interesting tercentenaries are those of Pierre Gassendi and Domenico Guglielmini Gassendi, born at Champtercier in Provence in 1592, was a child of poor parents, but rose to a high position in the Church He revived the Epicurean philosophy and was an opponent of Descartes's philosophical views In astronomy he was the first to observe a transit of Mercury (on November 7, 1631) which had been predicted by Kepler, and with Mersenne he carried out the first experiments on the velocity of sound For a few years he was professor of mathematics at the Collège Royal, but his health obliged him to give up lecturing in 1647 He died in Paris on October 24, 1655

Guglielmini, born at Bologna on September 27, 1655, at first devoted himself to astronomy, and in 1685 was appointed to the chair of mathematics at Bologna In the following year he was given general supervision of the "waters of the State", in other words, of irrigation This was an important task, and led to his publishing a valuable treatise on hydrostatics The grateful Bolognese created a chair of hydrometry for him in 1694, and three years later he published a classic work on rivers, "Della Natura de'Fiumi" Guglielmini also made some important observations on the crystallization of chemical salts, work which has been evaluated recently by Prof R Hooykaas, of Amsterdam[3] He was elected a Fellow of the Royal Society in 1697 and died in Padua in 1710

Before passing on to the centenaries of 1755, we should perhaps direct attention to the death on January 17, 1705, of John Ray, a naturalist whose importance would certainly justify a two hundred and fiftieth anniversary commemoration.

The eighteenth century saw the beginning of an era of scientific expeditions, and one of the earliest of these was that organized by the Imperial Academy of Sciences at St. Petersburg, under the patronage of the Empress Anne, to explore Siberia This was the "Great Expedition" of Vitus Bering, and the principal botanist was Johann Georg Gmelin (1709–55), one of the famous German family of that name, whose "Flora Sibirica" and "Reise durch Sibirien" are monumental records of an epic journey. Like many who went on this expedition, Gmelin died while still in his prime, on May 20, 1755 Another scientific writer and traveller of this period was the physician and botanist, Pierre Barrère (1690–1755), of Perpignan, who spent three years in Cayenne and published a detailed description of French Guiana

An event which was to have considerable influence on the development of chemistry took place in June 1755 This was the reading by Joseph Black to the Edinburgh Philosophical Society of his classic paper published in 1756 as "Experiments upon Magnesia Alba, Quicklime and some other Alcaline Substances" It was not only his discovery of carbon dioxide, but also the quantitative manner in which his experiments were carried out, that make this the opening of a new era in chemistry Another interesting event of the year was the founding by the Empress Elizabeth of the University of Moscow, the first Russian university

Turning now to the bicentenaries of scientists born in 1755, we note first that of the French chemist, Antoine-François Fourcroy, born in Paris on June 15 He was not yet thirty when appointed professor of chemistry at the Jardin du Roi, where he succeeded Macquer An eloquent lecturer, he did much to popularize the new nomenclature of chemistry based on the theory of Lavoisier He was a zealous supporter of the Revolution, and in this respect his relations with Lavoisier were less happy It has been suggested that by his conduct as a member of the Convention he contributed to the death of his irreplaceable colleague—an accusation that was refuted, one should add, by Cuvier Fourcroy died in 1809, on the very day on which he had been created a count of the French empire by Napoleon

Another Frenchman who belongs to this period is Nicholas-Jacques Conté (born 1755), a mechanical genius who came to the fore during the Revolution Supplies of graphite from Borrowdale were interrupted by the war with Britain, and in 1795 he invented the process by which all lead pencils are now made, using powdered graphite and clay In 1796, when experiments were being made with balloons for military purposes, he was placed in charge of all aerostatic establishments, and when Napoleon set out with the Egyptian expedition in 1798, Conté with his balloon corps accompanied him In Egypt his inventive genius proved invaluable to the expedition, cut off from home supplies after Nelson's victory in the Battle of the Nile, and it is said he seemed able to invent immediately anything that was required. He died not long after his return to France, in 1803

Two other Frenchmen born in 1755 are Jacques-Julien de Labillardière and F. D. de Reynaud, Comte de Montlosier. The former is the botanist whose valuable collections from a South Seas expedition fell into British hands as booty of war, but were released to the French government after representations had been made by Sir Joseph Banks, then president of the Royal Society. Montlosier, well known as a political writer, was also the author of a work on the volcanoes of the Auvergne, used by Von Buch and Sir Charles Lyell; in 1828 the latter spent "three delightful days" with the seventy-four year old Count at his château near Mont Dore. Montlosier died ten years later, in 1838.

Passing to Spain, an important bicentenary is that of Don Fausto de Elhuyar, born at Logroño on October 11, 1755. Don Fausto and his brother, Don Juan José, were skilled in metallurgy and mineralogy and are noted for having, in 1783, isolated metallic tungsten from its ore for the first time. Previously they had studied at Freyberg under the celebrated Werner and at Uppsala under Bergman. Don Fausto's expenses had been paid by the Sociedad Bascongada de Amigos del Pais (the Basque Society of Friends of their Country), and in 1782 he began to teach mineralogy at the Society's new college at Vergara (founded in 1777), where J. L. Proust was already professor of chemistry. In 1788 Don Fausto went to Mexico, having been appointed director general of mines by the King of Spain. There he founded the School of Mines, which was opened in 1792 and rapidly attained great prestige. He remained in Mexico for many years, but returned to Spain after the revolution and devoted himself to the mining industry of his native land. He died in Madrid, where the centenary of his death was impressively commemorated in 1933.

Another scientist of interest to geologists is the London physician, James Parkinson (1755–1824), who practised in London and was the first to describe a case of paralysis agitans, also known as 'Parkinson's disease'. Like many medical men, Parkinson was interested in geology, and he was one of the founders of the Geological Society. His "Organic Remains of a Former World" (1804–11), a general account of fossils, was for long a standard work; indeed, in 1833 it was reprinted, although its epistolary form made it somewhat long and cumbersome.

Another author of a monumental text-book was S. T. von Sömmerring (1755–1830), whose birthplace was also that of Copernicus, the Polish town of Thorn. His large treatise on anatomy was noteworthy both for its admirable illustrations and for the fact that its author had prepared editions in German and Latin at the same time. Von Sommerring also has a place in the history of the electric telegraph, for in 1808 he designed an apparatus consisting of thirty-five glass tubes, each representing a letter or number, which could act as voltameters when connected with a voltaic pile, and so could be used for signalling messages, albeit somewhat slowly.

Other inventors of the same period were Aimé Argand (1755–1803), a Swiss physicist who designed the oil burner that took his name, and Oliver Evans (1755–1811), an American who initiated the use of relatively high-pressure steam in the United States about 1800.

In reviewing the centenaries of scientists who died in 1855, the outstanding one is certainly that of Karl Friedrich Gauss, the mathematical genius who died on February 23 of that year, aged seventy-seven. Born at Brunswick in 1777, the son of poor parents, his remarkable gifts brought him while still a schoolboy to the notice of Ferdinand, Duke of Brunswick, who himself deserves grateful remembrance for financing Gauss's subsequent education. The young man soon became renowned, first as a mathematician and then for his calculations in the field of astronomy. He was elected a foreign member of the Royal Society of London in 1804. After the death of his ducal patron, Gauss was appointed director of the Gottingen Observatory, and here he remained for the rest of his life. In the field of pure mathematics, Gauss has been ranked with Newton, and like Newton he was reluctant to publish his discoveries. Only his diary, fortunately preserved, reveals how many discoveries he anticipated. His seal, a tree bearing a few fruits, with the motto "Pauca sed matura", illustrates his attitude towards publication. He was more than fifty years old when he began his famous studies of terrestrial magnetism, and then, with his young colleague Wilhelm Weber, he founded the absolute system of measurement of electricity and magnetism. With Weber he designed the magnetometer, and in 1833 they constructed the first electromagnetic telegraph, which linked the Observatory and the Physics Laboratory at Gottingen. In 1838 he received the Copley Medal of the Royal Society for his researches. Gauss was a man of wide culture, and in the midst of all his scientific work maintained a lively interest in literature and languages. At the age of sixty-two he took up the intensive study of Russian, and within two years he had become fluent, corresponding wholly in Russian with scientific friends in St. Petersburg. Indeed, the title of 'Prince of Mathematicians' so frequently applied to him scarcely seems adequate for his wide attainments.

Two French scientists who died in 1855 were J. C. Sturm and F. Magendie. Sturm, who discovered the theorem named after him, was born in Geneva in 1803, and in 1826, with J. D. Colladon, he was the first to measure the velocity of sound in water, using a bell suspended in Lake Geneva. François Magendie, born at Bordeaux in 1783, achieved fame in a very different field. He was the creator of the experimental technique in physiology, and in his experiments upon animals acquired an unenviable reputation for ruthlessness. He is particularly noted for giving the first experimental proof of the motor and sensory functions of the spinal nerve roots, and is also remembered gratefully by physiologists for his early recognition of the genius of Claude Bernard, whom he made his assistant. Magendie died at Sannois near Paris on October 7, 1855.

Two well-known English geologists, who both died in April 1855, were Henry Thomas de la Beche, first director of the Geological Survey, and George Bellas Greenough, first president of the Geological Society. Greenough, the older of the two, was born in London in 1778. He was a leading figure in the establishment of the Geological Society in 1807, and steadfastly countered the opposition of Sir Joseph Banks, who, as president of the Royal Society, disliked the formation of a new and independent scientific society. Greenough devoted much time to assembling material for a geological map of England and Wales, which was published under the auspices of the Geological Society in 1820, replacing that of William Smith. In 1854 Greenough exhibited a large-scale geological map of India, and when he died on April 2 of the following year at the age of seventy-six, he was in Naples on his way to the east to make further researches His valuable library and maps were presented to the Geological Society, and many of his specimens are in the collections at University College, London

Sir Henry de la Beche, born in London in 1796, died shortly after Greenough, on April 13 He had become a Fellow of the Geological Society in 1817, and of the Royal Society in 1819. He made many contributions to the geology of south-west England while still a young man, and in 1831 began to colour geologically the 1-in Ordnance maps of that region His own resources being insufficient, he obtained a grant of £300 from the Treasury to carry on this work, and in 1835 received an official appointment to continue the geological survey of Cornwall This was the beginning of the present Geological Survey, and in the succeeding twenty years de la Beche fostered its growth until he was directing the work of a considerable band of skilled men, as well as supervising a Museum of Practical Geology and the attached School of Mines. He was honoured with a knighthood in 1842, and a few months before his death received the Wollaston Medal, the highest award of the Geological Society.

The month of April 1855 was also that of the death of Dr. Martin Barry (born 1802), who, after graduating as M.D at Edinburgh in 1833, took up the study of embryology. In 1840 he was elected a Fellow of the Royal Society, from which he had received a Royal Medal the previous year One of his most important observations was that of the penetration of the ovum by the spermatozoon in the rabbit

Another Edinburgh graduate who was also a naturalist was George Johnston (born 1797), a founder of the Ray Society and for many years one of the editors of the journal now known as the *Annals and Magazine of Natural History* Johnston was a resident of Berwick-on-Tweed, where he was thrice mayor, and died there on July 20, 1855. A namesake who died a few weeks later was James Finlay Weir Johnston, a Scottish chemist, who after studying under Berzelius became the first reader in chemistry and mineralogy in the University of Durham, a position which he held until his death He was also chemist to the short-lived Agricultural Chemical Association of Scotland, and the author of a "Catechism of Agricultural Chemistry and Geology", which went into thirty-three editions in five years and was translated into nearly every European language

Two other interesting centenaries are those of the chemist C B Mansfield (1819–55), and the civil engineer and inventor Bryan Donkin (1788–1855) Mansfield is noted for having found a method of extracting benzene from coal-tar, a discovery which laid the foundations of the aniline industry Donkin, in addition to many inventions in the paper-making industry, in 1812 began in Bermondsey the commercial preservation of meat and vegetables in airtight tins, a process that was welcomed by seafarers and explorers long before it revolutionized the domestic kitchen

The list of those born in 1855 is noteworthy for including three past presidents of the British Association for the Advancement of Science Sir David Bruce, one of the great pioneers of medical research, was president at the Toronto meeting in 1924 Born in Melbourne, Australia, on May 29, 1855, he studied medicine at Edinburgh and then entered the Army Medical Service in 1883 While serving in Malta he investigated the disabling Malta fever (of much wider distribution than its name implies), and in 1886 discovered the micro-organism that caused the disease, although seventeen years elapsed before goat's milk was recognized as its carrier Next, working in Africa, Bruce discovered the trypanosome that is the cause of the fly disease in cattle and horses, and later, with others, was able to prove the connexion between the tsetse fly, Gambia fever and sleeping sickness Bruce received many honours for his brilliant researches He died in 1931, only surviving by a few days his wife who had constantly assisted him in all his work

In the year following Bruce's death, 1932, the president of the British Association was Sir Alfred Ewing, born at Dundee on March 27, 1855 He had been professor of engineering in Tokyo during 1878–83, during which period he began the researches in magnetism for which he received a Royal Medal in 1895 Professor at Cambridge during 1890–1903, where he is regarded as the virtual founder of the engineering school, he resigned to take up an appointment as Director of Naval Education, and then devoted his energies to the re-organization of scientific training in the Royal Navy. To the general public he is best known for his work during the First World War in 'Room 40', where the de-coding of secret wireless messages was carried on This work was followed by a long period of office as principal of the University of Edinburgh, during which the new science blocks known as King's Buildings that are a permanent memorial to his administration were erected In 1929 he retired to Cambridge, where he died six years later.

Frederick Orpen Bower, the Yorkshire botanist who died as recently as 1948, was president of the British Association when it met in Bristol in 1930 Bower was noted both as a morphologist and for his work on the origin of the land flora, which he discussed in several books, the latest being "Primitive Land Plants" (1935) Born at Ripon on November 4, 1855, and educated at Repton and at Trinity College, Cambridge, he reversed the more usual drift south and was regius professor of botany at Glasgow for forty years He received the Darwin Medal of the Royal Society in 1938

A British physicist who was also an extremely practical experimentalist was Sir Charles Vernon Boys, born at Wing, in Rutland, on March 15, 1855 By his choice of quartz fibres for torsional suspensions he made an important step forward in technique Boys procured fibres of the requisite fineness by the ingenious method of shooting from a cross-bow an arrow attached to a heated quartz rod, and later he used these fibres in the apparatus that he designed for his classic determination of the constant of gravitation This apparatus is now in the Science Museum at South Kensington Boys, who received from the Royal Society a Royal Medal in 1896 and the Rumford Medal in 1924, died in 1944

Two others who will be remembered this year for discoveries that became of great industrial importance are C. F. Cross (1855–1935), who in obtaining viscose from cellulose in 1892 laid the foundations of the artificial silk industry, and William Friese-Greene (1855–1921), the Bristol inventor whose patent for a camera and projector, filed in June 1889, is held to support his priority over Edison in the field of cinematography.

An eminent French meteorologist, L. P Teisserenc de Bort, was born in Paris on November 5, 1855, and died at Cannes in 1913 He was a pioneer in the investigation of the upper air, using balloons carrying self-recording instruments He showed there were two divisions of the atmosphere, and named the upper isothermal layer the stratosphere

Other noteworthy centenaries are those of Bohuslav Brauner (1855–1935), the Czech chemist who after studying under Roscoe at Manchester carried out important researches on the chemistry of tellurium and the rare earths , H F Geitel (1855–1923), who collaborated with Elster in work on the photoelectric cell , and Christian Bohr (1855–1911), a Danish physiologist who made important studies in the physiology of respiration There is also Percival Lowell, born at Boston on March 13, 1855, who established the Flagstaff Observatory in Arizona Here he carried out detailed studies of Mars, as well as a number of spectroscopic studies of planets, comets and spiral nebulæ, work which remains of permanent value, even if his frequently expressed belief in the existence of life on Mars has failed to find general support

[1] Hay, Denys, "Polydore Vergil" (Clarendon Press, Oxford, 1952)

[2] Taylor, E G R , *Scot Geograph Mag* 43, 341 (1927)

[3] Hooykaas, R , *Atti della Fond G Ronchi, Florence*, 8 (1953)

WHAT IS A VIRUS?[*]

By Dr KENNETH M. SMITH, F.R S
Plant Virus Research Unit (Agricultural Research Council),
Molteno Institute, Cambridge

THERE are two main theories on the nature of viruses , one supposes that they are parasitic organisms which have developed parasitism to the highest possible degree Laidlaw has suggested that parasites, through the indolence of living a 'borrowed life', gradually give up making substances essential for their growth because they are always at hand in the cells of the host The other theory suggests that some viruses at all events are not of external origin at all, but are derived from the cell proteins of one organism and only become viruses when transferred to the cells of another different organism I have not attempted to answer the question which supplies the title to this discourse, but leave it to the reader to choose for himself between the alternative answers to the question "What is a Virus ?"

Only the viruses affecting plants and insects are dealt with, since these have been my special study

Plant Viruses

The earliest known record of a plant virus disease, although of course it was not recognized at that time as such, is to be found in a description published in 1576 of a variegation in the flower colour of tulips This is now known to be a virus of the mosaic type Change in the colour of the flowers, or 'breaking' as it is called, is a fairly common symptom of plant virus diseases Besides the tulip, the blood-red wallflower frequently shows a yellow flecking of the petals, and this bodes ill for the grower of cabbages and cauliflowers in the district since the virus which affects the colour of the wallflower causes a severe disease in cruciferous crops

The symptoms caused by viruses in plants take a great variety of forms , besides the simple mosaic pattern on the leaves, there are other leaf changes There may be numerous concentric rings with a central spot, or leaf distortions of various kinds Sometimes the leaf blade is entirely suppressed, leaving only a string-like tendril, or again there may be outgrowths of secondary leaves from the undersurface of the leaf blade , these are known as enations Frequently the whole plant is distorted or dwarfed, with many short stems , this type of disease is known as a witch's broom In one interesting virus disease which affects leguminous plants, the chief symptom is the production of tumours which seem analogous to the various virus tumours produced in animals

Viruses attack all kinds of flowering plants, including forest trees In Great Britain the most important virus diseases are those attacking the potato, the sugar beet, raspberries, strawberries and the brassica crops In North America the virus diseases of stone fruit trees, peaches, plums and cherries, are becoming a very serious problem, and there are signs that the same problem will have to be faced in Britain also in the near future

In addition to some of the main symptoms of virus-diseased plants, one rather interesting internal change should be described In the cells of plants infected with some viruses, particularly that of the tobacco mosaic disease, there can be seen by the aid of the ordinary microscope a rather curious body with a superficial resemblance to an organism Indeed, when these bodies—*X*-bodies they are called—were first observed, they were described by some workers as the causal organism of the disease These *X*-bodies are of two kinds, amorphous and crystalline, and it has been shown recently that the crystalline inclusions are actually aggregates of the virus itself This has been done by picking out the crystal from the cell, dissolving it in a micro-drop of water and photographing it on the electron microscope (Williams and Steere[1]).

One property of plant viruses which distinguishes them from most bacterial and fungal plant pathogens is their close relationship with insects Many viruses depend entirely upon insects for their transfer from diseased to healthy plants. The insects which carry plant viruses—termed vectors—are mostly, but not all, of one kind , they belong to the order Hemiptera and are of the sap-sucking, not leaf-eating, type The commonest insect of this kind, of course, is the aphid, and many viruses are transmitted from plant to plant by these insects

There is another kind of sap-sucking insect belonging to the same order as the aphids and known as a leaf-hopper These insects are concerned, particularly in North America, with the spread of a number of important plant viruses In certain of these cases it has been proved that the plant virus actually multiplies inside the insect. This is very interesting, because a plant virus which multiplies inside an animal must have some affinities with the animal viruses It has been shown by Black[2], working in America, that a virus affecting clover is transmitted from the parent insect to its offspring He also found that the virus could be carried on for a period of four years covering fifteen generations without the insects having access to a further source of virus This shows, fairly conclusively, that the virus must have been multiplying inside the insects during that time, otherwise it would have involved a dilution of 10^{-17}, which is far greater than any virus could stand

Before concluding this brief account of the relationship of plant viruses with insects, mention must be made of an interesting virus, only recently discovered, causing the disease known as turnip yellow mosaic. This virus, curiously enough, cannot be transmitted by aphids or any other sucking insect. The vector in Nature is the common flea beetle, but in experimental studies it has been found to be transmitted by any biting insect without salivary glands. The explanation lies not so much in the absence of the salivary glands as in the fact that insects such as beetles, which lack these glands, regurgitate while feeding. In so doing, the virus which has been swallowed and which remains in the fore part of the gut for a week or more is brought into contact with the healthy leaf in the process of eating, and the new plant thus becomes infected. Thus it comes about that any biting insect which regurgitates while feeding can transmit the virus. It has been proved experimentally that such insects as grasshoppers and earwigs, which fulfil these conditions, can also transmit the turnip yellow mosaic virus.

---

[*] Substance of a Friday Evening Discourse delivered at the Royal Institution on November 12

One of the most interesting relationships between some viruses and their hosts is that of latency. Broadly speaking, this means that a virus may be present in an organism without causing a disease. A familiar example of latency is herpes simplex or 'cold sore' in man. The herpes virus remains symptomless unless stimulated by some external factors to multiply and become virulent. These external stimuli differ greatly and vary from emotional disturbances, exposure to ultra-violet light (sunlight) or the advent of another virus, for example, that of the common cold. A truly latent virus, however, never produces a disease in its host and cannot apparently be made to do so. There are two good examples of this type of latency among the plant viruses. One is invariably present in a well-known potato variety, King Edward, and no plant of that variety has ever been found free of the virus. The other occurs at certain periods of the year in a very high percentage of the commercial sugar beets, not only in Britain but so far away as Southern California. It is not possible to detect the presence of either of these viruses in their hosts except by transfer of the sap to other plants, which then do show symptoms of virus infection. The most interesting fact about these two viruses is that apparently they have no natural means of spread, and yet the latent sugar beet virus occurs in a very large number of plants without it being, so far as we know, either seed- or insect-borne. It may be, of course, that there exists a method of spread of which we know nothing, but in the meantime these two viruses lend support to the idea that some plant viruses may be normal cell constituents in one species and become a virus when transferred to another plant.

Certain plant viruses occur in such high concentration in the plant that it is possible to extract them by means of chemical precipitation methods and purify them to such an extent that they crystallize. Many plant viruses, however, because of instability or low concentration in the host, cannot be isolated in sufficient quantities, but about half a dozen have now been crystallized and the crystals may be eight- or twelve-sided, or take the form of flat plates.

It has been mentioned earlier that we now know quite a lot about the size and shape of viruses, but this could not be achieved by means of the ordinary microscope. With the electron microscope, however, it is possible to obtain a resolving power of 5 mμ, and the latest instrument is said to give a resolution of 1 mμ (10 A.). This, of course, is far smaller than any known virus, and we can now see and photograph any virus which can be obtained in a suitably pure condition. The first virus to be photographed on the electron microscope was that of tobacco mosaic—appropriately enough, since it was the first virus to be discovered. The photographs confirmed a previous belief that the particles are long rods and showed that they measure about 300 mμ in length by about 15 mμ in width. Several other plant viruses have been photographed and some of them are spherical or near spherical, whereas others are rods.

It is hoped, however, to do more with the electron microscope than observe the size and shape of viruses. It is possible now, by means of the technique of cutting ultra-thin sections of fixed material, to observe the virus inside the cells of the host.

Very little is known as to how viruses multiply, and the examination of sections of infected cells at different stages of the disease may help to solve the problem. In looking for viruses in sections of infected cells, it helps matters if the virus in question is of a characteristic shape. For example, it is easier to see the long rods of tobacco mosaic virus inside the cell than it is to find some of the very small spherical viruses. Sections of cells infected with tobacco mosaic virus show the virus particles in and around the chloroplasts.

Insect Viruses

The viruses which attack insects are for some reason the least investigated of all the virus groups. We know that there are several quite different kinds of viruses, but the majority have this in common that they attack the larval stages rather than the adults. The best known are the 'polyhedral diseases', so called because of the presence in the tissues of infected larvæ of huge numbers of polyhedral, or many-sided, crystals. These crystals have been recognized for many years and much controversy has raged about them. However, it is now known that they are not the virus itself, but the virus is contained within them. This is a point of difference from the plant virus crystals, which are actually composed only of virus particles.

It has recently been shown in our laboratory at Cambridge that there exist two entirely different and distinct types of polyhedral diseases. There is first the classical nuclear type, in which the virus starts to multiply and the polyhedra to form, inside the nuclei of cells in the tracheæ, blood and skin of the diseased caterpillar. It was shown not many years ago by Bergold[3], with the electron microscope, that if the crystals are treated with weak sodium carbonate they dissolve, leaving behind a thin membrane containing numerous rod-shaped virus particles.

In the second type of polyhedral disease, only recently discovered (Smith and Xeros[4]), the virus multiplies and the polyhedra form in the cytoplasm and not in the cell nucleus. Moreover, the polyhedra are confined to the gut of the diseased caterpillar. When this type of crystal is treated with weak sodium carbonate and photographed on the electron microscope, the result is somewhat different. The crystal only partially dissolves, leaving a honeycomb-like skeleton, and there is no residual membrane. Further work has shown that the virus particles are spherical and not rod-like, and each round virus particle fits into one of the round holes in the polyhedral crystal. We thus have the interesting phenomenon in which the shape of the virus particle is correlated with a particular type of crystal, site of

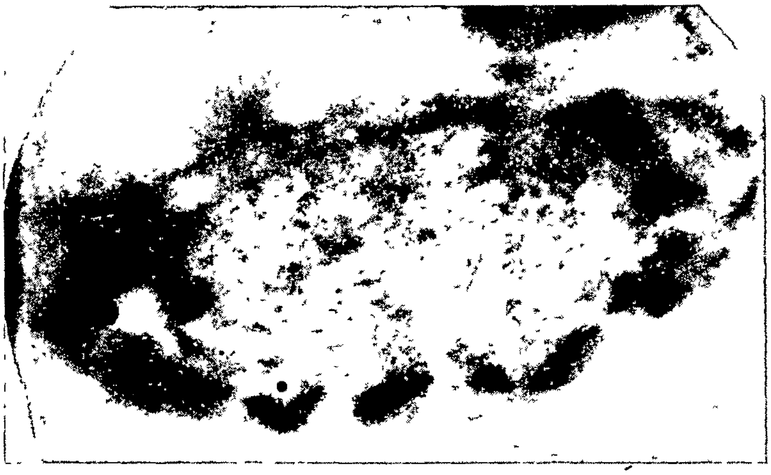


Fig 1 Thin section through a diseased blood cell of the leatherjacket (*Tipula paludosa*) showing the greatly enlarged nucleus filled with virus rods The largest of the bodies seen between the nuclear membrane and the edge of the cell is a polyhedral crystal × 1,000

multiplication and particular set of symptoms A further interesting fact is that each of these virus particles is composite, consisting of four or five extremely minute spheres (Smith and Xeros[5])

While the majority of polyhedral diseases attack the larvæ of Lepidoptera, butterflies and moths, there is one interesting virus of this type which affects the larva of the cranefly or daddy-long-legs (Diptera) This fly larva, known as a 'leatherjacket' because of its tough integument, is an agricultural pest of some importance

The virus causes a blood disease, a kind of leukæmia, and the number of blood cells is enormously increased and pack the blood cavities Towards the end of the disease the polyhedral, or rather crescent-shaped, crystals form at one end of the enlarged pathological blood cells (Fig 1) These crystals have very extraordinary properties and behave quite differently from the polyhedral crystals of the Lepidoptera When put into alkali, they become transformed into long thin threads or worm-like shapes, but when returned to water they resume their crystalline appearance Thin sections of these remarkable crystals reveal the presence inside them of many virus rods

Another type of virus disease infecting caterpillars is known as a 'granulosis' or 'capsular disease' Here the place of the polyhedral crystal is taken by numbers of very small granules, each of which contains one or sometimes two virus rods instead of hundreds as in the polyhedra A disease of this type attacks a caterpillar which is a pest of the tea bushes in Ceylon, known as the 'nettle-grub' When the granules of this disease are treated with weak alkali, the outer capsule dissolves leaving only a thin 'ghost', and inside this is a second capsule containing the virus rod The reasons for this curious 'Chinese box' arrangement are not known

A very interesting virus infecting the leatherjacket, in addition to the polyhedral virus already mentioned, has recently been discovered in our laboratory and was later briefly described by Xeros[6] This virus, the particles of which tend to have a hexagonal shape, occurs in very high concentration in the insect, and when a drop of fluid is extracted from a diseased larva the particles arrange themselves in the regular manner shown in Fig 2

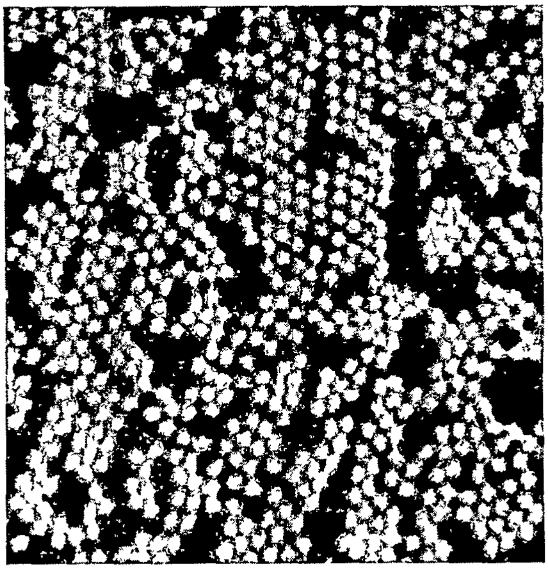


Fig 2 A drop of fluid from a leatherjacket infected with a new virus disease, note the large numbers of virus particles and their regular arrangement × 10,000

Thin sections of the fat body of an infected larva show such enormous numbers of virus particles that the whole material of the organ seems to be converted into virus The arrangement of the virus particles inside the fat body is very interesting, in addition to the large numbers of isolated particles, there occur numerous masses or agglomerations of virus particles which look superficially like some of the intracellular inclusions of other insect viruses These masses, however, appear to be composed only of virus particles (Fig. 4).

In thin sections of the virus particles themselves (Fig 3) a darker area or 'nucleus' is visible, suggesting that they may have a composite nature similar to that of the cytoplasmic polyhedral virus previously described

At the present time we know very little of the way in which viruses multiply, and it is hoped to learn more of this process by the examination of thin sections of cells under the electron microscope. The nuclear polyhedral diseases of insects, to which we have already referred, are very suitable for this kind of study Because the main initial focus of virus multiplication is in the cell nucleus, it is possible to make an intensive study of this circumscribed area From an investigation made at Cambridge on the nuclear disease of the silkworm, the following sequence of events has been built up (Smith and Xeros[7]) First, the infected nucleus enlarges greatly until it practically fills the cell Then the chromatic net or central mass begins to form, and from the edges of this, and of the chromatin lining the nucleus, the virus rods begin to appear, very much as if they were being pushed out from within At this stage there are no free virus rods in the 'ring zone' of the nucleus

It is interesting to note that as the virus rods are apparently extruded, they seem to be longer than the normal rods and can be seen dividing In the next stage many free virus rods appear, and it should be noticed that they are without the enveloping capsule which surrounds each virus rod when inside the polyhedral body When the interior of the nucleus contains many virus rods, the protein of which the polyhedral crystals are made begins to form It is, in fact, actually possible to see the virus rods being incorporated into the crystals as it forms around them In the last stage the nucleus becomes filled with the polyhedral crystals, in which are incorporated the virus rods, and there are no free virus particles visible in the nucleus At this stage the nuclear membrane bursts and the polyhedral crystals are liberated

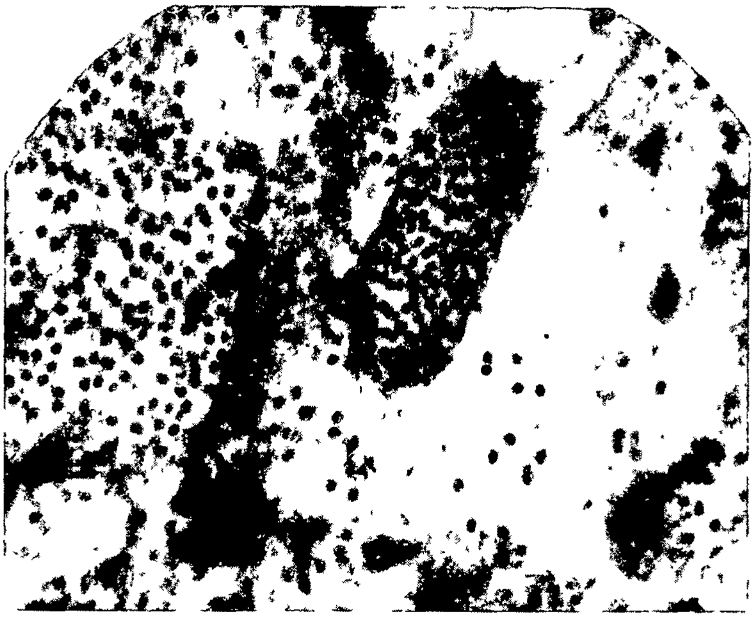


Fig 4 Section through part of the fat-body of an infected leatherjacket, note one of the many aggregates of virus particles × 16,000

Electron micrographs by S Vernon-Smith

Much the same kind of process seems to take place in the diseased blood cells of the leatherjacket Thin sections of these, when photographed in the electron microscope, reveal the enlarged nucleus containing a central body, which is often shaped like a horseshoe Around this is a second or pericentral body, while outside this again is a less dense zone in which many virus rods can be seen.

We know, therefore, from our studies so far of these nuclear virus diseases, that almost all the chromatin of the infected nuclei is organized into a central virus-producing chromatic mass or net which has a large surface area

Viruses in the Control of Insect Pests

There is a practical aspect to the study of insect viruses, and mention must be made of the possibility of using them to control noxious insect pests So far, the method used has been to breed numbers of the caterpillar pest in question and infect them with a polyhedral virus disease to which they are susceptible By this means a great quantity of polyhedra can be obtained, and these are used to start an artificial epidemic This method has been used with success in California and Canada[8,9] These were cases of controlling an insect pest by artificial propagation of a natural infection We hope, however, to take the matter further by providing a virus to attack an insect pest which does not suffer naturally from a virus disease We have shown recently that, contrary to accepted opinion, the polyhedral viruses of insects are not so specific in their action as was thought, and that cross-infection is quite possible Using a combination of two viruses originally obtained from caterpillars of the painted lady butterfly (*Vanessa cardui*), we have infected a large number of different species of caterpillars Some experiments in the control of two well-known insect pests have been made, using the same combination of viruses The pests in question are the caterpillars of the winter moth (*Operophtera brumata*) and the pine looper (*Bupalus piniarius*) Foliage of apple and pine needles contaminated with the two polyhedral viruses were fed to the larvæ The results were quite surprising, 75 per cent of the winter moth caterpillars and 100 per cent of the pine loopers were killed by a polyhedral disease Examination of the dead larvæ showed that they had died of a cytoplasmic virus disease of the gut So far as this goes, it is satisfactory, but the experiments have still to be made on a large scale out-of-doors, and methods of biological control are liable to go wrong because there are so many variable factors

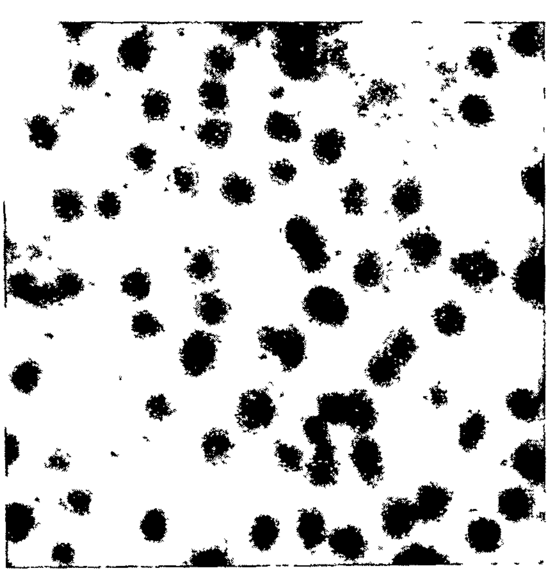


Fig 3 Section through some of the virus particles shown in Fig 2, note the darker centres in some cases, suggestive of a composite nature × 42,000

---

[1] Williams, R C, and Steere, R L, *J Amer Chem Soc*, **73**, 2057 (1951)

[2] Black, L M, *Nature*, **166**, 852 (1950)

[3] Bergold, G H, *Z Naturforsch*, **2b**, 122 (1947)

[4] Smith, Kenneth M, and Xeros, N, *Parasit*, **43**, 178 (1953)

[5] Smith, Kenneth M, and Xeros, N, *Parasit*, **44**, 400 (1954)

[6] Xeros, N, *Nature*, **174**, 562 (1954)

[7] Smith, Kenneth M, and Xeros, N, *Parasit*, **44**, 71 (1954)

[8] Thompson, C G, and Steinhaus, E A, *Hilgardia*, **19**, 411 (1950)

[9] Bird, F T, *Canad Ent*, **85**, 437 (1953)

KAFUAN STONE ARTEFACTS IN THE POST-AUSTRALOPITHECINE BRECCIA AT MAKAPANSGAT

By C K BRAIN, PROF C VAN RIET LOWE and PROF R A DART

Discovery and Geology

DURING October 1954, the main breccia sections at Limeworks, Makapansgat, South Africa, were sampled for mineralogical analysis The profile of one of the most complete and interesting of these sections is reproduced in Fig 1

The 15-ft thick deposit of light pink breccia, which rests directly upon the basal travertine, has been referred to by Dart[1] as the australopithecine-bearing "grey white clays". Afterwards King[2] termed it the "Older Red Sand". A heavily calcified deposit, it contains numerous weathered dolomite blocks, as well as a band of rounded water-worn pebbles at the 40-ft level The layer as a whole can be regarded as a contaminated stalagmite, and certainly represents a very slow accumulation It is followed in sequence by 35 ft of what has been described as calcified "loess" by Bosazza, Adie and Brenner[3] in 1946 and by Dart[1] in 1947 A careful examination of this material, however, has shown that the term 'loess' certainly cannot be applied. Throughout the greater part of its depth, this layer consists of a calcified soil containing very numerous pieces of rock Almost without exception these rock pieces show signs of abrasion typical of river action, while many of them have been very effectively rounded This fact, together with the presence of water-worn quartzite pebbles derived from higher up the Makapan Valley, clearly indicates that one is dealing here with a coarse river aggradation deposited inside the cave at a time when its opening was close to river-level The present elevation of the surface of the deposit above the modern river-bed is 160 ft Considering, then, that the original cave entrance must have been rather above the present surface of the deposit, some impression is gained as to the amount of erosion which has occurred since the whole deposit was laid down

The conclusion that part of the Limeworks cave-filling represents a river gravel is a significant one But more significant still is the observation that this gravel contains stones showing unmistakable signs of artificial fracture. In view of this fact it becomes vital to establish the relationship between the gravel bed and the underlying australopithecine-bearing breccias

At Limeworks, the greatest concentration of bone is to be found in the heavily calcified breccias resting directly upon the travertine floor It is from these that all the australopithecine fossils have been obtained. Mineralogical study has shown that these breccias contain a large proportion of residual cave material, and that they formed very slowly at a time when the cave opening was small The great length of time required for their formation accounts for the concentration of bone within them These bone-rich strata may be correlated with the 'light pink breccia' in Fig 1 The transition at the 35-ft level from this breccia to the less heavily calcified gravel represents the first rapid introduction of outside material through the suddenly enlarged cave entrance It is therefore my opinion that the section shown in Fig 1 can be regarded as a single phase of accumulation, and that no major temporal unconformity occurs at any point. This conclusion was first reached on faunal grounds by Cooke[4] in 1947 when he wrote "On the percentages of extinct and living forms and the number of identical species present in the lower, middle and upper zones of the Limeworks Quarry, it is clear that there is no very great difference in age between these zones". This means, therefore, that there can be no very great age difference between the gravel deposit and the australopithecine-bearing breccia.

Consideration will now be given to the relative dating of Limeworks in comparison with the other Transvaal australopithecine sites It has been found that the most profitable approach to the problem of relative dating of the cave deposits is through an estimation of the past climates which prevailed at the times of their accumulations Such an estimation has been made possible by various mineralogical and analytical means which will be described in detail elsewhere The most direct of these is through percentage abundance determinations of wind-rounded sand grains in the breccia sands If the necessary precautions are taken, such determinations provide a direct clue to the dryness of the conditions prevailing at the times in question

The climatic deductions considered in conjunction with the faunal successions for the various sites have led to the establishment of the following sequence in time, which reads from the bottom up

Dryness	Site
Minimum—increasing	Kromdraai (2 sites)
Decreasing	Swartkrans
Maximum	Sterkfontein

In his paper on the dating of the australopithecines, Oakley[5] places Limeworks slightly earlier than

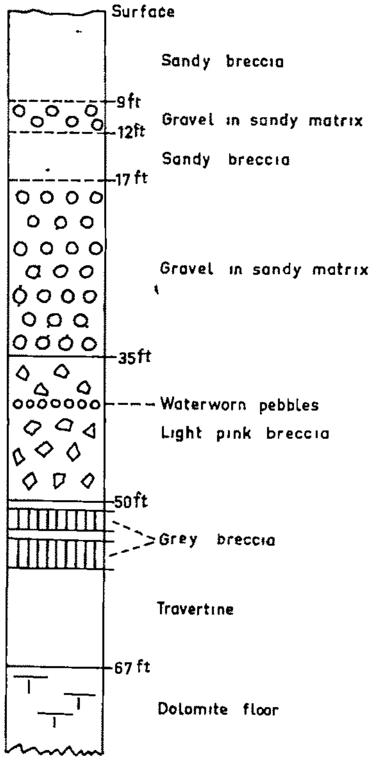


Fig 1

Sterkfontein, but the climatic indications now obtained from Limeworks show it to fall more readily somewhere between Sterkfontein and Swartkrans, but almost certainly overlapping the latter to some extent. This conclusion is supported by the faunal evidence. In considering the baboon genera *Simopithecus* and *Papio*, recent, and as yet unpublished, work by Freedman has shown that neither occurs at Sterkfontein, that the former is present at Limeworks, while both have been obtained from Swartkrans. Likewise, *Equus* does not occur at Sterkfontein but has been found at both Limeworks and Swartkrans.

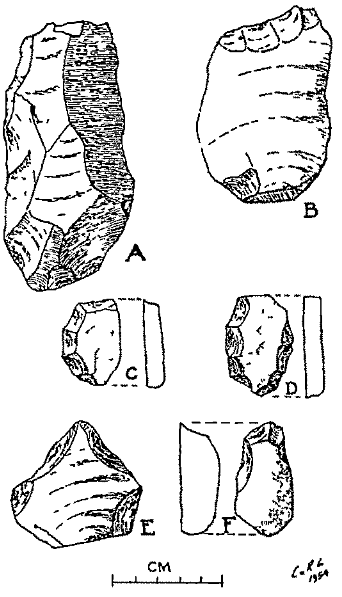


Fig 2

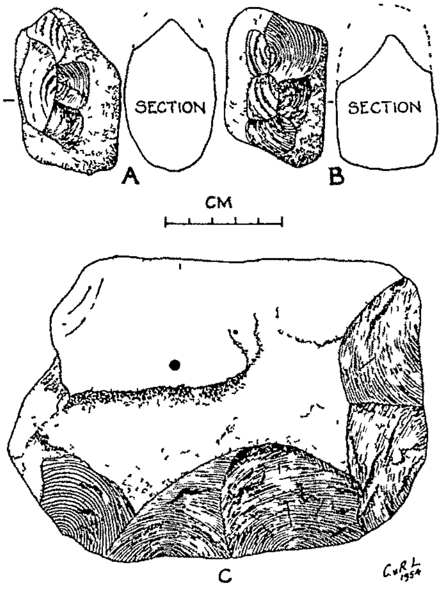


Fig 3

The complete evidence for the position of the sequence Sterkfontein – Limeworks – Swartkrans – Kromdraai in the Pleistocene time-scale will be considered in detail elsewhere. It may be stated, however, that this evidence is not in full agreement with Oakley's[5] Kageran–Kamasian date for the sites, but tends to indicate both their greater antiquity, and the presence of an extra pluvial period to which no African stage-name can at present be applied.

To sum up, it has been suggested that in the Limeworks deposit one is dealing with a coarse river aggradation superimposed directly upon the australopithecine horizon, that there is no significant temporal unconformity between these horizons, and that the whole succession is comparable in age with the Sterkfontein–Swartkrans sequence. It has also been stated that stones showing possible artificial fracture were obtained from the gravel bed. These were all taken from the basal five feet of the gravel, from, in fact, the 30–35 ft. level of the profile in Fig. 1. They come, therefore, from a position directly above the australopithecine horizon, and were submitted for examination by Prof. van Riet Lowe, whose conclusions concerning them may now be presented.

C. K. B.

The Artefacts

Of the 129 trimmed, utilized or damaged stones Mr. C. K. Brain submitted to me from the gravels that overlie the australopithecine-bearing breccias at the Limeworks site in the Makapan Valley, only seventeen are undoubted artefacts. Of these, fifteen are of deeply leeched dolomite, one of vein quartz and one of dark grey quartzite. They include ten flake artefacts, four pebble artefacts, two artefacts on thin slabs of dolomite and one split pebble.

The artefacts on flakes include those illustrated in Fig. 2 (*A*, *B* and *E*). *A* and *B* were struck from cores only *after* other and possibly similar flakes had been struck. *B* was later trimmed into an end-scraper, and *E* into a double-notch-and-tooth type of tool.

The four artefacts on water-worn pebbles include the two tools illustrated in Fig. 3 (*A* and *B*), the large core shown in Fig. 3 (*C*) and the split pebble illustrated in Fig. 2 (*F*). *A* and *B* are as typical of the Oldowan as they are of the Kafuan Culture, but *F* is decidedly Kafuan.

At least seven flakes were deliberately removed from the large core (Fig. 3, *C*): five in one direction, in the typical block-on-block manner, and two in the opposite direction.

The artefacts on thin slabs of dolomite (Fig. 2, *C* and *D*) show steep secondary, almost vertical, trimming around their peripheries in the best 'Hope Fountain' manner.

The split pebble (Fig. 2, *F*) was split longitudinally down its major axis in the manner of an ortholith and trimmed into a beaked or rostro-carinate form (Stage I) typical of the Developed Kafuan Culture[6].

On the evidence before us, this assemblage can only be assigned to the Developed Kafuan Culture as this occurs in Uganda and in the disturbed upper layers of the Basal Older Gravels in the 200-ft. terrace of the Vaal River at Klipdam[7].

The discovery of Kafuan-type artefacts in a terraced river gravel in an undisturbed stratified sequence of deposits immediately overlying australopithecine-bearing breccias in a cave is unique. When we add to this the known occurrence of Chellean- and Acheulean-type tools that cover the full range of the great African Hand-axe Culture of the Earlier Stone Age of Middle Pleistocene times in more recent deposits in, and in the immediate vicinity of, this amazing valley, some in caves and some in exposed sites, followed stratigraphically by Middle and Later Stone Age remains of Upper Pleistocene and Holocene times, we are encouraged to hope that the establishment of a Quaternary chronology independently of any set up elsewhere is, among other things, now well within our reach.

C. v. R. L.

General

Nearly thirty years ago the Makapansgat Limeworks bone breccia was recognized as a site of early human occupation[8]. Twelve years later, Early Stone

Age implements were found about a mile farther up in the same valley in the sealed Cave of Hearths deposit[9] The general stratification of the Limeworks breccia, the basal grey layer of which afterwards yielded repetitive discoveries of *Australopithecus prometheus* and the concomitant fauna, was described at the first Pan-African Congress on Prehistory at Nairobi[1]. Up to the present time, as at all other australopithecine sites, no stone artefacts have been found in the grey breccia or in the superincumbent 25–50 ft of lime-consolidated cavern deposit

The 40–60 ft of consolidated and semi-consolidated cavern breccia overlying the stalagmitic floor at the Cave of Hearths has been completely excavated since 1947 through the generosity at the outset of the late Dr Bernard Price and latterly of the Wenner-Gren Foundation. This excavation has furnished a continuous stratigraphical story of human habitation and cultural progression from the Earlier Stone Age of Middle Pleistocene times through the Middle and Later Stone Ages to the recent coming of Bantu and European

During September and October 1954, however, Mr C K Brain, in the course of the comparative mineralogical survey of the known australopithecine breccias which he has been enabled to undertake by a subvention from the Wenner-Gren Foundation, extracted from the first 5 ft of the gravel beds overlying the grey breccia in the south-eastern section of the deposit a number of dolomite stones that appeared to him to have been intentionally flaked

The Kafuan pebble culture of Uganda, so named by Wayland[10] from artefacts found in the terraced gravels of the westward-running Kafu affluent of Lake Albert, is the earliest and most primitive stone culture known in the African continent[6] Farther south in Uganda it occurs in its Earliest Kafuan form in the 270-ft terrace of the eastward-running Kagera affluent of Lake Victoria The Developed Kafuan, while the oldest and most primitive stone culture known in South Africa, first appears in Uganda in the later 200-ft. terrace of the Kagera River (*vide* ref 6)

The only implemental evidence hitherto found accompanying australopithecine remains are the fractured and worn bones, jaws and horns, that Dart claimed as the by-products of their predatory habits This discovery of Kafuan-type artefacts in a gravel bed in a stratified sequence of deposits immediately overlying the grey stratum, which nearby in the same cavern system is an australopithecine-bearing bone breccia, is unprecedented It opens up the astonishing prospect that Makapansgat may place within our grasp in a single South African valley a continuous story of human handiwork and a consecutive chronology of mankind from the dawn of the Pleistocene to the present day

R A D

---

[1] Dart, R A Proc Pan African Congress on Prehistory, 1947, p 96 (1952)

[2] King, L C, *Trans Roy Soc S A*, 33, 121 (1951)

[3] Bosazza, V L, Adie, R J, and Brenner, S, *J Natal Univ Coll Sci Soc*, 5 (1946)

[4] Cooke, H B S, Proc Pan African Congress on Prehistory, 1947, p 26 (1952)

[5] Oakley, K P, *Amer J Phys Anthrop*, 12, 9 (1954)

[6] Van Riet Lowe, C, "The Pleistocene Geology and Prehistory of Uganda", Part 2 Prehistory, Geol Survey Uganda Memoir No VI (1952)

[7] Van Riet Lowe, C, S Afr Archæol Bull, No 30, Vol 8, pp 27–31 (1953)

[8] Dart, Raymond A, *S Afr J Sci*, 22 (1925)

[9] Van Riet Lowe, C, *S Afr J Sci*, 35, 371 (1938)

[10] Wayland, E J, "Some Primitive Stone Implements from Uganda" (Govt Press, Uganda, 1923)

OBITUARY

Prof Enrico Fermi, For Mem R S.

THE news of the death on November 28 of Enrico Fermi came as a shock to his numerous friends, many of whom had seen him only a few months previously in his customary strength and good humour. By the public at large he will be remembered as the man who opened the gates to the atomic age he led the team which, on December 2, 1942, produced the first self-sustained nuclear chain reaction—the first 'atomic pile' But he had been a leader in the field of nuclear physics long before that A few months after Irène and Frédéric Joliot had discovered artificial radioactivity in 1934 he showed, with his collaborators at the University of Rome, that neutrons can be used to produce radioactive isotopes of nearly all nuclei For a year or two thereafter any nuclear physicist who could read Italian was in great demand—he had to translate the short communications which appeared in the *Ricerca Scientifica*, nearly every one revealing some new and startling phenomenon The discovery of 'slow neutrons', of their strong absorption in selected elements such as cadmium, their ability to disintegrate boron, releasing energies millions of times their own, their diffusion in paraffin wax, the selective absorption of different neutron 'groups' in different elements seldom has there been such an explosive outburst of brilliant, wholly unexpected discoveries

Of special significance was the observation that neutron bombardment of uranium caused the formation of active products which Fermi thought were trans-uranic elements In this he was wrong, they were fission products, elements lighter than uranium, but this was not realized until four years later. So it might be said that Fermi was the first to cause and observe nuclear fission, though he did not recognize it

All this was the work of a superb experimenter, quick to design relevant tests with simple means, yet equally capable of conducting the wide-flung research and development which led to the first atomic pile. These achievements alone would have secured Fermi an honourable place in the history of experimental physics

But actually Fermi started his career as a theoretician, and it is for his work in theory that his name will be remembered through household words such as the Fermi statistics, the Fermi theory of beta-decay, and the 'fermion' (any particle which obeys Fermi statistics) It was in 1926 that he applied Pauli's exclusion principle to systems of many identical particles (Dirac did the same independently a little later), and developed the peculiar kind of statistical mechanics required to describe the thermal properties of such systems In ordinary gases the deviations from 'classical' statistics are irrelevant except at very low temperatures. But Fermi statistics gave the clue to the behaviour of electrons in metals here was a 'gas' for which even white heat represented a very low temperature, and a great many puzzling facts—such as the absence of any considerable contribution from the conduction electrons to the specific heat—fell into place when Sommerfeld (1928) used Fermi statistics to create the modern theory of electrons in metals

Fermi's theory of beta-decay was published in 1934 Again it was based on an idea of Pauli the idea of postulating a 'neutrino'—a light, neutral and practically unobservable particle—to account for the variable amounts of energy missing in beta-disintegrating processes The theory was immediately successful it accounted for most of the facts then known and predicted new ones which were duly verified Some refinements—which fitted naturally into the original framework—were added later, and it is now certain that Fermi's theory gives a correct account of all aspects of the beta-process—the mutual transformation of protons and neutrons—though the place of this process in the general scheme of things is still one of the main mysteries of to-day's physics

After the War, Fermi returned to academic work at the University of Chicago The atomic piles he had created were powerful sources of neutrons, and he used them in the experimental attack on fundamental problems, in particular that of the interaction of neutrons and electrons But he did not neglect theory his work on the origin of the cosmic radiation (1947), on the production of multiple mesons (1950) and on the interpretation of meson-scattering experiments at the big new synchro-cyclotron was witness to the unabated vigour of his mind

Born in 1901, Enrico Fermi was quick in establishing his position professor in Rome by 1928, member of the Accademia d'Italia in 1929, Nobel Prize in 1938 Since 1938 he had lived in the United States, with his wife and two children

Fermi's strength was not subtlety or high-flown imagination, but strong common sense combined with perfect mastery of his subject No vagueness or mysticism for him the essence of his work was clarity His papers were written in a style so crystal-clear that the tremendous intellectual effort which had created them was out of sight. His lectures were perfectly planned and delivered· with the skill and humour of a showman His personality, unassuming yet dominant, often provocative but always tolerant, forceful and yet easy-going, will be remembered by all who met him His joy of living was contagious, and his death is a great loss both to the world of physics and to his many friends all over the world.

O R FRISCH

NEWS and VIEWS

Directorship of the Royal Horticultural Society's Gardens: Dr H. R. Fletcher

DR H. R. FLETCHER, director of the Royal Horticultural Society's Gardens at Wisley, has been appointed to succeed Dr J. M Cowan as assistant to the Regius Keeper of the Royal Botanic Garden, Edinburgh. Dr Fletcher graduated at Manchester in 1929 and in the same year was appointed assistant lecturer in botany in the University of Aberdeen under the late Prof Craib There he became interested in taxonomy, especially in the flora of Siam. After taking the degree of doctor of philosophy, he was appointed to the staff of the Royal Botanic Garden, Edinburgh, in 1934 There he continued his work on the Siamese flora and graduated doctor of science in 1939 In collaboration with Sir William Wright Smith he has published a long series of papers on the sections of the genus *Primula* in the *Transactions of the Royal Society of Edinburgh*, the *Transactions of the Botanical Society of Edinburgh* and in the *Journal of the Linnean Society*. Then followed a revision of the genus *Omphalogramma* and numerous articles in scientific and horticultural journals on the genera *Codonopsis, Cremanthodium, Aconitum, Potentilla* and *Incarvillea* In 1951 Dr Fletcher left Edinburgh to become director at Wisley After some four years there, he is again strongly attracted to the line of work he pursued for so long at Edinburgh and is returning there shortly.

Mr F. P. Knight

MR F P KNIGHT, who is to succeed Dr Fletcher as director at the Royal Horticultural Society's Gardens, is a Devonian, fifty-two years of age, who commenced his horticultural career in 1915 at Werrington Park, Launceston, Cornwall, at that time owned by Mr J C Williams, who did so much to support George Forrest in his botanical exploration work in Western China. During 1919–23 Mr. Knight was a probationer gardener in the Royal Botanic Garden, Edinburgh, where he worked mainly in the Propagating Department, and helped with the experimental work on plant propagation from cuttings The experience gained laid the foundation of Mr Knight's favourite branch of horticulture. After a period of nearly two years as a student gardener at Kew, he was for four years in charge of the Arboretum nurseries there This was followed by a period with Messrs Baker's, of Codsall, Wolverhampton, where he specialized in the commercial production of large quantities of rock garden plants, and also supervised the firm's landscape planting activities for two years He then went to Knap Hill Nursery, Ltd, Woking. In 1940 Mr Knight was appointed horticultural officer to the Directorate of Camouflage, Ministry of Home Security, becoming senior officer as the work developed. In April 1944 Mr Knight joined Messrs. R C Notcutt's Nursery, Woodbridge, as general manager, and in 1945 was appointed managing director Mr Knight has been active in the Royal Horticultural Society, serving on the Society's Floral Committee and the Camellia and Rhododendron Committee He has been a member for several years of the Technical Sub-Committee of the Roads Beautifying Association

American Society of Tropical Medicine and Hygiene Awards

THE following awards were recently presented at a meeting of the American Society of Tropical Medicine and Hygiene:

LePrince Award to Prof. B G. Maegraith, professor of tropical medicine in the University of Liverpool. The award consisted of a medal and a prize of 500 dollars contributed by the Michigan Chemical Co. Mr J A LePrince, after whom the award is named, also received the medal, which had not been struck at the time he was first honoured by the National Malaria Society

Bailey K. Ashford Award for research on chemotherapy of malaria and amœbiasis to Dr Joseph Greenberg, of the Laboratory of Tropical Diseases, National Microbiological Institute, National Institutes of Health, Bethesda, Maryland. The award is given to a scientist less than thirty-five years of age and consists of a medal and a prize of 1,000 dollars, furnished by Eli Lilly and Co, Indianapolis, Indiana

Theobald Smith Medal to Dr George Cheever Shattuck, professor emeritus of tropical medicine at Harvard University.

The Charles Franklin Craig Lecture was given by Dr Albert B Sabin, research professor of pediatrics, University of Cincinnati Medical School

Institute of Metals : Medal Awards

The Institute of Metals has awarded the following Medals *Institute of Metals (Platinum) Medal,* for 1955, to Dr C. J. Smithells, director of research of the British Aluminium Co , Ltd , Gerrards Cross, in recognition of his services to metallurgical science, to the metal industries and to the metallurgical profession , *Rosenhain Medal,* for 1955, to Dr W A Baker, research manager of the British Non-Ferrous Metals Research Association, London, in recognition of his outstanding contributions to knowledge in the field of physical metallurgy, with special reference to the influences of gases and shrinkage on the soundness of cast metals , *W H A Robertson Medal and Premium,* for 1954, to Prof H Ford and Mr J G Wistreich, for their paper on problems of the control of dimensions, shape and finish in the rolling of sheet and strip and in the drawing of wire (*J Inst Met*, 82, 281 , 1954)

Polarographic Society: Inaugural Meeting

The inaugural meeting of the Polarographic Society was held on November 9 in the Lecture Theatre of the Pharmaceutical Society of Great Britain, 17 Bloomsbury Square, London, W C 1, with Mr W J Parker in the chair The meeting was attended by more than forty people interested in the subject, who had come from many parts of Britain Mr Parker reviewed the steps leading to the formation of the Society According to the constitution, the objects of the Society are "to advance and promote the science of polarography in all its aspects and to provide educational facilities in polarography through discussion and any other medium" He said that the Society also hopes to facilitate the discussion of day-to-day problems as well as further an understanding of the basic principles In referring to the enthusiastic support given to the new Society by the "polarographic profession", Mr Parker stressed that membership is open to any person interested in the objects of the Society , the annual subscription has been fixed at 10*s* Four papers were then presented which in themselves epitomized the objects of the Society they were "A Brief Introduction to Polarography", by Dr A L Glenn lecturer in pharmaceutical chemistry in the School of Pharmacy, University of London , "The Polarograph with Derivative and Phase Selective Additions", by G L Young, Research Department, Cambridge Instrument Co , Ltd , "Potential Pitfalls in Practical Polarography", by Mrs B Lamb, chief chemist of Tinsley (Industrial Instruments), Ltd , and "The Application of Polarography to Pyrimidine Chemistry", by Mrs N Luthy, of Stanford University, Stanford, California (now working at the University of Manchester on a grant from the British Empire Cancer Research Fund) Further information about the Polarographic Society can be obtained from V. S Griffiths, Chemistry Department, Battersea Polytechnic, London, S W.11

Courses in Advanced Technology in Britain

Following up the statements in Parliament on higher technological education (see p 22), the Minister of Education, Sir David Eccles, gave in a written answer on December 14 the names of twenty-four technical colleges in which courses in advanced technology had been approved for an increased grant of 75 per cent under Circular 255 Eight of these are in London The remaining colleges include the Birmingham College of Technology, Bradford Technical College, Cardiff College of Technology and Commerce, Huddersfield Technical College, Leicester College of Technology and Commerce, Manchester College of Technology, Nottingham and District Technical College, Royal Technical College, Salford, and North Staffordshire Technical College, Stoke-on-Trent Ninety technical colleges had applied for this grant , sixty-three had not qualified for it, and three requests are still being considered

University of Leeds Publications and Theses during 1951–52

Under the title "Publications and Titles of Theses, 1951–2" (pp 57 , 1954 , 6*d*) the University of Leeds has issued a pamphlet listing by faculties (and including the Institute of Education, the Department of Adult Education and Extra-mural Studies, and the Library) the publications of which members of the University are authors or joint-authors, and which appeared in print during October 1, 1951–September 30, 1952 Titles of theses accepted by the University during the same period for the degrees of master and doctor are similarly listed in an appendix There is an index of authors It is proposed to issue similar pamphlets for subsequent academic years

International Commission on Zoological Nomenclature Elections

The International Commission on Zoological Nomenclature announces the election of the undermentioned zoologists to be members of the International Commission on Zoological Nomenclature, with effect from the dates stated K H L Key, principal research officer, Division of Entomology, Commonwealth Scientific and Industrial Research Organization, Canberra, in succession to Joseph Pearson (resigned) (October 15, 1954) , Alden H Miller, professor of zoology and director of the Museum of Vertebrate Zoology, University of California, Berkeley, in succession to J L Peters (deceased) (October 29, 1954) , Ferdinand Prantl, vice-director, Národni Museum, Prague (October 30, 1954) , Wilhelm Kuhnelt, professor in the Zoological Institute of the University, Vienna (November 6, 1954) , F S Bodenheimer, professor of zoology, Hebrew University, Jerusalem (November 11, 1954) , Ernst Mayr, Alexander Agassiz professor of zoology at Harvard College, Cambridge, Mass. (December 4, 1954) , Enrico Tortonese, professor of zoology, Istituto e Museo di Zoologia, Universita di Torino, Italy, in succession to Prof Lodovico di Caporiacco (deceased) (December 16, 1954)

Colonial Service : Recent Appointments

The following appointments have recently been made in the Colonial Service D J Billes (senior agricultural officer, Gold Coast), assistant director of agriculture, Gold Coast ; I S Hutcheson (agricultural officer, Bechuanaland Protectorate), director of agriculture, Bechuanaland Protectorate , E M Brown (senior assistant conservator of forests, Jamaica), conservator of forests, Jamaica , I E M. Watts (meteorological officer, Singapore), assistant director, Malayan Meteorological Service, Singapore , H W Hockin (inspector of mines, Federation of Malaya), senior research officer, Department of Mines, Federation of Malaya , P T Nelson, agricultural officer, Nigeria , Mrs W M H Sesseler, government chemist, Gold Coast , N V. Williams, fisheries officer, Nigeria A J T Bayles, assistant conservator of forests, North Borneo , G J. Journeaux, assistant conservator of forests, Nyasaland , B. P Singh, assistant conservator of forests, British Honduras , C K Burton and J H Duncan, geologists, Federation of Malaya , O von Knorring, chemist, Geological Survey, Federation of Malaya , A F Trendall and J Walsh, geologists, Uganda , W. G C Bearcroft, medical research officer, West Africa Virus Research Institute, Nigeria , A R Jenkins, senior scientific officer, East African Tsetse and Trypanosomiasis Research and Reclamation Organization, East Africa High Commission , B. A. Mitchell, scientific officer, Federation of Malaya , T. Owens, veterinary officer, Northern Region, Nigeria , W G C Parker, veterinary officer, Somaliland Protectorate.

Electromagnetic Wave Theory Symposium in Ann Arbor, Michigan

An international symposium on electromagnetic wave theory, sponsored by Commission VI of the International Scientific Radio Union and the University of Michigan, will be held in Ann Arbor at the University of Michigan during June 20–25 Five topics will be considered propagation in doubly refracting media in wave guides (for example, ferrites) , boundary-value problems of diffraction and scattering theory , work in antenna theory of fundamental importance , forward scattering , and multiple scattering (that is, of light by colloidal particles) Developments at millimetre wave-lengths will be particularly considered Anyone wishing to read a paper should submit by March 31 an abstract of not more than two hundred words to the chairman of the symposium, K. M. Siegel, Willow Run Research Center, University of Michigan, Ypsilanti, Michigan Further information on all other points can be obtained from J. W Crispin, jun , at the University of Michigan, Ann Arbor, Michigan.

The Night Sky in January

Full moon occurs on Jan 8d 12h. 44m , U.T., and new moon on Jan 24d. 01h 06m The following conjunctions with the moon take place Jan 9d 03h , Jupiter 2° N. , Jan 18d 03h , Saturn 6° N , Jan 20d 0h , Venus 6° N , Jan 25d 16h , Mercury 5° S , Jan 29d 05h , Mars 6° S In addition to these conjunctions with the moon, Jupiter is in conjunction with Pollux on Jan 24d. 21h , Jupiter 6 3° S. Mercury sets an hour after the sun on January 15 and 1h 40m after sunset on January 31, but is too close to the sun in both cases to be favourably seen Venus is a morning object, its times of rising being about 4h 20m up to the middle of the month and 4h 45m at the end of the month Its stellar magnitude varies from −4 3 to −4 and the visible portion of the illuminated disk from 0 348 to 0 528 Mars sets about 22h 25m throughout the month, and, as its declination increases from −5° to nearly 5°, it is becoming better situated for observation in the northern hemisphere It is not very close to any bright star, but its eastward movement from Aquarius into Pisces is obvious during the month Jupiter, which rises early in the afternoon (at 15h on January 31), is visible throughout the night and morning hours, stellar magnitude −2 2. Its westward movement in Gemini as it approaches δ Geminorum is easily seen Saturn is a morning object, rising at 3h 45m , 2h 55m and 2h on January 1, 15 and 31, respectively. Its declination is about 16° S., and it does not attain a great altitude in the British Isles , its apparent eastward movement towards γ Libræ continues until the beginning of March Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich Jan. 4d. 15h. 45 8m , ζ Ari (*D*) , Jan 6d 21h 04 9m , 121 Tau (*D*) , Jan 27d 18h 46 0m , ϰ Psc. (*D*), where *D* refers to disappearance The earth reaches perihelion on January 4, its distance from the sun being then a little less than 91½ million miles The Quadrantids meteors attain their maximum on January 3

Announcements

Dr S J Folley, head of the Physiology Department, National Institute for Research in Dairying, Shinfield, has been elected a corresponding member of the Société de Biologie of Paris

Dr T Robertson, assistant director (England and Wales) of the Geological Survey and Museum since 1949, is to retire on March 31 after thirty-eight years with the Survey He will be succeeded by Dr F. M Trotter, who is at present district geologist in charge of the Manchester office of the Geological Survey , and Mr J V Stephens will become district geologist at Manchester

Mr J Lamb, director of the Tea Research Institute, Ceylon, has been appointed director of the West African Cocoa Research Institute, in succession to Mr J. West, who has retired Mr. Lamb is taking up his new post in the latter part of 1955

The Society for Psychical Research is offering a prize of £50 for an essay, preferably not exceeding three thousand words, on any topic relevant to the work of the Society. Entries close on June 30 Further information can be obtained from the Secretary, Society for Psychical Research, 31 Tavistock Square, London, W C 1

The Population Council, Inc , of New York, is offering further fellowships for advanced training in the study of population at the predoctoral and postdoctoral levels. Fellowships will be available for study in universities in the United States and elsewhere for the academic year 1955–56, preference being given to qualified applicants from countries other than the United States and Europe The basic stipend of 2,500 dollars per annum may be increased by allowances for travel, dependants, etc. Application forms (to be returned by March 1) and further information can be obtained from the Population Council, Inc , 230 Park Avenue, New York 17, New York

R303

The Exhibition of Israeli Scientific Papers at the Israeli Consulate, 18 Manchester Square, London, W 1, which was to have closed on December 22 will remain open until January 7

The Wellcome Historical Medical Museum, which for the past seven years has been carrying on its activities at 28 Portman Square, London, W 1, has now removed to the Wellcome Research Institution at 183–193 Euston Road, N W 1 Exhibitions dealing with primitive medicine and with child-welfare through the ages are open to the public in the new premises (Monday to Friday, 10 a m –5 p m)

HIGHER TECHNOLOGICAL EDUCATION IN GREAT BRITAIN

In replying to a question in the House of Commons on November 23 regarding higher technological education, the Chancellor of the Exchequer, Mr. R. A. Butler, said he had nothing to add to his statement of July 13; but when pressed with regard to the position in Wales, he indicated that he intended making a further statement which would give a broader picture than that which he had given previously. This promise was repeated by Sir David Eccles, the Minister of Education, when replying to questions on this subject, in the debate on the Queen's Speech on November 30, arising out of the reference in that Speech to the Government's intention to "stimulate the expansion of facilities for higher technological education, so that advances in scientific research may be matched by increased industrial efficiency and production". Sir David dealt particularly with questions on technical education from Mr. Malcolm MacPherson, who suggested that within the Ministry of Education a division should be set up dealing specifically with technical and technological questions. Sir David agreed that there is real urgency to treat technical education as a major problem, and he announced the lifting of restrictions as to the industries for which new technical education facilities could be provided. The amount of new work which could now be started for technical education would be increased by about £2½ million a year. He added that the Secretary of State for Scotland is also anxious to see more rapid development of facilities for technical education and will be letting the education authorities concerned have details of his proposals shortly.

The promised statement was made in both Houses of Parliament on December 7. In the House of Lords, the Lord President of the Council, Lord Salisbury, stated that the Government's plans provide for the massive expansion of the Imperial College of Science and Technology, London, and for major developments at Glasgow, Manchester, Leeds and Birmingham, including also developments on a fairly large scale at Cambridge and Sheffield, and specialized developments at other centres in Great Britain, notably at Edinburgh, Newcastle, Southampton, Nottingham and Swansea. Some of them are to be financed by industry and some by Treasury grants. The Government is endeavouring to avoid either excessive centralization or undue dispersal of resources, and is concentrating its efforts on institutions which are already receiving Treasury grants. In its view, higher technological education must be closely linked with other university studies, and those who are studying technology should work closely with those who are occupied with the more fundamental problems of science and with its application in other fields. The problems of technology are the problems of human relations as well as of science, and in training for industry the humanities have an important part to play. Where a technological institution and a university are associated, as in London, Glasgow and Manchester, this linking of studies could be achieved. If, however, new universities are to be established in other centres by upgrading the technical colleges, it will be necessary to provide them also with additional departments, and the nation cannot afford the necessary resources of teachers, buildings and money. Accordingly, Lord Salisbury indicated that the Government does not propose to start entirely new technological institutions; but it will seek close association between the universities and industry, and it has been encouraged by the recent founding of new chairs in technological subjects with funds raised from industry. Lord Salisbury added that the universities are becoming more responsive to industrial needs by designing post-graduate classes to meet particular local requirements and by inviting industry to assist with instruction.

About one-eighth of the total recurrent grants to the universities are used for technology, in the narrower sense of the term, or about £3 million a year. Additional recurrent grants for technology, amounting to £196,000, have been made for the present academic year; these will be increased to £404,000 next year and to £704,000 for the academic year 1956–57. This will be in addition to the extra cost of salaries announced in November. For building and equipment the capital expenditure and liabilities against public funds incurred in recent years for technology, in the narrow sense, now amount to about £10 million, including a number of projects authorized last July. Further building has been authorized to the extent of £1 million, in addition to the normal university building programme for the year 1955–56, and the Chancellor will be prepared to consider, for starting in the following year, other technological projects included in the University Grants Committee's plans for developments beginning in the quinquennium. The total capital cost of this project over ten years may well be about £15 million.

With regard to the expansion of the Imperial College of Science and Technology in London, Lord Salisbury stated that building work is already in progress on the northern part of the site in South Kensington to the extent of about £1.2 million, including equipment. Further progress will soon require the release of some other parts of the site from their existing use, and the Chancellor of the Exchequer has now authorized new building work to proceed in Bloomsbury to enable existing University of London activities (such as the Warburg Institute) to be transferred there in due course from South Kensington. Approval has been given for the erection of part of the north section of the British Museum (Natural History) and the completion of the new centre block of the Science Museum to release accommodation now occupied by the Aeronautical Collection of the Science Museum. To minimize the disturbance of the Indian Collection of the Victoria and Albert Museum, plans have been approved which will enable a substantial part of this Collection to be permanently on view in the main building of the Museum. Alternative accommodation will be needed eventually for that part of the Royal College of Art which is housed in the same building as the Aeronautical Collection. The Government is still considering the future of the Imperial Institute, and it is hoped to reach an early decision.

In reply to a question in the House of Commons on December 14, regarding the development of the Royal Technical College, Glasgow, into a technological university, the Secretary of State for Scotland, Mr. J. Stuart, said that the Government believed that the progress of higher technological education in Glasgow could best be served if the College and University worked out a relationship which, without hampering the development of the College, enabled their work to be co-ordinated. The Government had invited the two institutions to enter into discussions with the view of evolving a satisfactory scheme.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, INDIA

THE Council of Scientific and Industrial Research, India, was established in 1942 to administer the Industrial Research Fund, created to foster industrial development in India. The Council was charged with the promotion and co-ordination of scientific and industrial research in India, including the institution and financing of specific researches and with encouraging the utilization of the results of such researches. Its functions also include the establishment or assistance of special institutions or departments for specific studies of particular industrial problems, the award of research studentships and fellowships, the establishment and maintenance of laboratories, workshops, institutes and organizations for further scientific and industrial research and their utilization, the collection and dissemination of information and the publication of scientific papers. The development of the Council's work and its present activities are clearly and attractively set forth in a volume just issued by the Council* and which does ample justice to the energy and foresight which the Council has brought to bear for the past twelve years on problems of scientific and industrial development in India.

The development of the Council's work from that of the Industrial Intelligence and Research Bureau established in 1935 is described in an introductory chapter, including an account of the work of the Research Planning Committee appointed in 1943 and of the First Reviewing Committee of 1947, out of the recommendations of which came the National Research Development Corporation (1953) and the Board of Engineering Research (1950). The general organization of the Council, its advisory bodies and laboratories is outlined in the second chapter of the volume, and this is followed by a concise account of the work which has been carried out or is in progress in the laboratories for which the Director of Scientific and Industrial Research is responsible. The next hundred pages of the report are occupied by an account of the research programmes of the various national laboratories, which include the following (dates of opening given in brackets): National Physical Laboratory of India, New Delhi (1950); National Chemical Laboratory, Poona (1950); National Metallurgical Laboratory, Jamshedpur (1950); Fuel Research Institute, Jeelgora (1950); and the National Botanic Garden, Lucknow (1953). The total is brought to fifteen by the following institutes dealing with particular branches of applied science: Central Glass and Ceramic Research Institute, Calcutta (1950); Central Food Technological Research Institute, Mysore (1950); Central Drug Research Institute, Lucknow (1951); Central Road Research Institute, Delhi (1952); Central Electro-Chemical Research Institute, Karaikudi (1953); Central Leather Research Institute, Madras (1953); Central Building Research Institute, Roorkee (1953); Central Salt Research Station, Bhavnagar (October 1954); and the Central Electronics Engineering Research Institute, Pilani (1953). Not all these laboratories are fully working yet, as may be judged from the dates of opening.

This impressive record of work carried out or projected mainly during the past five years is followed by an account of the extensive investigations which have been or are being sponsored by the Board or the Council of Scientific and Industrial Research through its various research committees in such varied fields as scientific instruments, radio research, the ionosphere, high-altitude research, artificial rain, the measurement of geological time in India, gas turbines, the dyestuffs industry, biochemistry, malaria chemotherapy, pharmacology, the vanaspati industry, essential oils, plastics, and atomic research. Special committees have been appointed from time to time to deal with specific problems such as synthetic petrol, power alcohol from bagasse, research and development of gas turbine and jet propulsion engines in India, and low-cost housing.

Two chapters on the patent activities of the Council and the means taken to assist the utilization in industry of the results of the investigations it has sponsored and on the publications of the Council are followed by a brief note on the Indian National Scientific Documentation Centre, established at New Delhi in 1952 under the administrative control of the Director of the National Physical Laboratory. Besides some notes on the way in which the activities of the Council are financed and on its other activities, such as the co-operative research associations and the fellowships and scholarships instituted by the Council, the volume includes full lists of staff and of the personnel of the several boards and research committees, of research schemes, of patents and patent applications on behalf of the Council and of publications, including a classified bibliography of scientific and technical papers during 1940–53.

Simultaneously with this volume, the report of the Second Reviewing Committee*, constituted with Sir Alfred Egerton as chairman to report on the activities of the Council during the past five years, has been published; while the development of the Council's work has clearly been influenced by the experience of the Department of Scientific and Industrial Research in Great Britain, it is equally clear that there has been no slavish copying but that attempts have been made to shape both the organization and activities in accordance with Indian needs and conditions. The Reviewing Committee records the considered opinion that the twelve very fine modern laboratories which have been built are well sited and designed and have been well equipped at a very reasonable cost and that, except for certain important developments to which the Committee directs attention, they cover a range of research in science and industry which appears to be adequate for the next four years, although expenditure on research in India is far from being on the scale of highly industrialized countries, such as the United States or the United Kingdom. Recurrent grants to the Council from the Central Government have increased from 1,100,000 rupees in 1942–43 to 17,350,000 rupees in 1953–54, recurrent expenditure increasing from 695,611 rupees in 1942–43 to 12,928,765 rupees in 1952–53.

The policy of the Council in establishing these national laboratories and institutes has, in the Committee's opinion, been fully justified; the directors have been well chosen, the staffs are keen and are doing good work. The Reviewing Committee does not recommend any reorganization, but it makes some suggestions to improve the efficiency of operation and co-ordination. For example, the directors should be given as much freedom as possible in administration, with more time to exercise scientific guidance, the number of research committees—at present twenty-five—should be kept within bounds, and committees should be terminated when their work does not warrant two or three meetings a year, and further consideration of the relations between the national laboratories and institutes and the universities is recommended so as to ensure that the whole scientific organization operates in concert

---

* Council of Scientific and Industrial Research, India. A Review. Pp. 142. (New Delhi: Council of Scientific and Industrial Research, 1954.)

* Report of the Second Reviewing Committee of the Council of Scientific and Industrial Research. Pp. viii+98. (New Delhi: Council of Scientific and Industrial Research, 1954.)

There are sensible suggestions for co-operation in this field, including the interchange of facilities and of staff and welcoming the establishment of a University Grants Commission to provide grants for ensuring salary scales to attract staff of high quality, and the Committee stresses the importance of encouraging research at the universities and higher technological institutes Emphasizing equally the importance of co-operation with industry, it recommends that the liaison officer at the Council's headquarters should be responsible for furthering all such collaboration between the Council's institutes and laboratories and other research organizations Special attention is directed to the need for closer co-ordination and co-operation between the Council and the medical and agricultural research services, and more active co-operation with government departments is also recommended to facilitate utilization of the results of research carried out under the Council For the same purpose, as much help as possible should be given to the National Research Development Corporation, and the institutes should be assisted to establish pilot plants

The Reviewing Committee favours the establishment of further research associations where the size of an industry would justify this procedure, and it is obvious that, with regard to the utilization of research results, the dissemination of information, development and the formulation of research programmes, experience in India is not dissimilar from that in Britain The Committee's remarks as to the way in which the Council could give the measure of direction to the research done under its ægis necessary to ensure that it is related to India's needs and to the general advance of science are of considerable interest Ideas, it recognizes, must come mainly from the centres of research and, as research programmes, or less formally, they are discussed at meetings of the Council's research committees At this stage they should be related to the general plan for India and to the state of science and technology, and the Reviewing Committee suggests that the principal executive officer and director of the Council should be able to call together such members of the Advisory Board, directors and advisory committees of the laboratories and others from medical or agricultural research or the universities as would be needed to assess the importance and priority of particular ideas, and to suggest suitable laboratories within or without the organization where the research could be initiated He would thus be enabled to present to the Advisory Board of the Council a directive in relation to the programme which is submitted to the Board for review at least twice a year.

The developments which the Reviewing Committee considers desirable to complete the Council's cover of India's requirements are the Institute of Mining Research and the Central Mechanical Engineering Research Institute, both of which are to be established, the latter at Calcutta, mainly through private benefaction, and in this connexion the Committee comments on the need to attract young engineers to undertake research It has also been agreed to accommodate a Telecommunications Research Institute in the National Physical Laboratory, where the Defence Science Laboratory is also temporarily housed It recommends that full opportunities should be given for astronomical research in India, so as to utilize the ability for mathematical analysis and physical investigation for which Indian scientific workers are particularly noted, and that the Council should at least foster astronomical research in the universities and other centres The proposal to establish meteorological stations is welcomed and a centre for geophysical research is also recommended.

Provision for atomic energy is regarded as adequate, but some concentration of research effort on the utilization of solar energy, either direct or by chemical or biochemical means, is recommended, as well as further attention to the de-salination of water and concerted efforts to conserve, improve and recover the soils of India Physiological research requires full attention, and genetics also needs adequate cover. The Committee concludes its report with a tribute to the work already accomplished in so short a time and to the ability of the Council's chief executive officer, Sir Shanti Bhatnagar

DEEP-WATER MOVEMENTS IN THE OCEAN

MUCH less is known about water movements in the depths of the oceans than about surface currents The oceanic circulations, however, involve movements of water at all levels, with vertical as well as horizontal components, so that the movements in the various layers are to some extent dependent on one another Deep-water movements are therefore of interest to meteorologists as well as to marine physicists, biologists and geologists.

A Geophysical Discussion on this subject took place at a meeting of the Royal Astronomical Society on October 22 Dr G E R Deacon (National Institute of Oceanography), who was in the chair, referred to a quotation from Croll, towards the end of the past century, to the effect that the cause of ocean circulations was a question belonging to the domain of physics and mechanics, whereas few physicists or mathematicians of note had given much attention to it, this, he said, is no longer true The contributions to the Discussion, continued Dr Deacon, would show evidence of various ways in which problems of oceanic circulation are being tackled theoretically and by laboratory experiments as well as by observations in the oceans themselves

In the first paper, Prof K F. Bowden (University of Liverpool) gave a brief account of the main features of the oceanic circulation below the surface layers, as deduced from the observed distributions of temperature, salinity, oxygen content and other properties He referred to various estimates which have been made of the velocities of the deep-water movements, such as those based on the balance between horizontal flow and vertical or lateral mixing, and particularly to the charts of currents at 800 m. and 2,000 m. in the Atlantic Ocean deduced by Defant on the basis of the absolute dynamic topography Most estimates agree in order of magnitude, giving the velocity of flow of the Antarctic

The Study of Prehistory

J. G. D. CLARK

The inaugural lecture of the new Disney Professor of Archaeology at Cambridge. *2s. 6d. net*

Excavations at Star Carr

J. G. D. CLARK

A full account of the finds—'discoveries amongst the richest of their kind'—at an early Mesolithic site near Scarborough. In his last chapter Professor Clark sets Star Carr in the context of European prehistory. There are also chapters on lake-stratigraphy, pollen-analysis and vegetation by D. WALKER and H. GODWIN and on faunal remains by F. C. FRASER & J. E. KING. 24 plates, 80 figures *63s. net*

Active Transport and Secretion

EDITED BY J. F. DANIELLI & R. BROWN

The eighth Symposium of the Society for Experimental Biology held in July 1953. *45s. net*

CAMBRIDGE UNIVERSITY PRESS

Industrial Dust

New Second Edition

PHILIP DRINKER

Professor of Industrial Hygiene, Harvard School of Public Health

THEODORE HATCH

Professor of Industrial Health Engineering, Graduate School of Public Health, University of Pittsburgh

Available shortly from your bookseller

McGraw-Hill London

The culmination of extensive practical application, this book is the work of authors who have been associated with the field in teaching, research and practical consulting work throughout their professional careers

It presents a critical presentation of dust control in relation to the health of workmen, analysing not only dust conditions but also methods of dust control, how clean the air should be and how to clean it

The new second edition contains rewritten matter, revision and additions, to such an extensive degree as to make it virtually a new book

The work is divided into three major sections

1. **The physical substances composing dust and fume suspensions, and their effects upon man ;**
2. **Analysis, measurement and microscopy of fine dust ;**
3. **The practical control of dust and the use of respiratory protective devices.**

New material includes a bibliography covering developments in the field since 1936, a description of the engineering methods which have contributed to the gradual control of silicosis, and a detailed presentation of dust respirators whose use has now been accepted as sound industrial practice. Completely new illustrations reflect the latest changes in methods and techniques

Relating their material to an over-all health scheme, the authors approach their subject comprehensively in its engineering, laboratory and medical aspects

9 × 6 inches 371 pages 71s 6d

Aspects of Deep-Sea Biology

N. B. MARSHALL, M.A.

An outline of life found in the deep oceans, and of the physical nature of the deep sea, and the ways in which this information is obtained. The drawings by the author's wife in black-and-white, and colour, make this one of the most beautifully illustrated scientific books to be produced for a long time 35*s.*

General Principles of Geology

J. F. KIRKALDY, D.Sc., F.G.S.

A new text-book for University students by the Head of the Geology Department of Queen Mary College, London Modern theory is adequately covered but practical and economic applications of geology from water supply to road-making are by no means overlooked 25*s.*

Man and Energy

Prof. A. R. UBBELOHDE, F.R.S.

"An entertaining and well illustrated account of the way in which the muscular energy of men and animals has been replaced for many purposes by energy from coal, oil, water power and nuclear fission The author brings to the subject a lucid style, a dry wit and an eye for the apt statistic that make the book a pleasure to read " *Times Educational Supplement.* 18*s*

The Gyroscope Applied

K. I. T. RICHARDSON, M.A.

"Intended for all who have heard the name gyroscope and would like to know exactly what it is, why it works and how it is used at sea and in the air " *The Nautical Magazine.* 30*s*

All the above books are fully illustrated

Hutchinson's Scientific and Technical Publications

New and forthcoming books

The Chemistry of Lipids of Biochemical Significance

J A LOVERN, D Sc, F.R I C

(Monographs on Biochemical Subjects)

This book presents in concise form an account of those aspects of lipid chemistry most likely to be of general interest to biochemists It is, however, sufficiently detailed and authoritative to be of almost equal value to the specialist in lipid chemistry

With 2 diagrams 8*s* 6*d*

The Nitrogen Metabolism of Micro-Organisms

B A FRY

Lecturer in Microbiology, University of Sheffield

(Monographs on Biochemical Subjects)

This monograph provides a convenient introduction to one important section of microbial biochemistry The underlying theme is none other than that known to all biologists as the 'Nitrogen Cycle,' and an attempt has been made to analyse some of the component steps of the cycle from the standpoint of the biochemistry of the various reactions and the micro-organisms concerned

With 3 plates and 15 diagrams 9*s* 6*d*

The Infra-Red Spectra of Complex Molecules

L J BELLAMY

Principal Scientific Officer, Ministry of Supply

'May well become the analytical handbook for those using IR techniques, and workers in the field owe a debt to both author and publisher for its production ' *British Bulletin of Spectroscopy* 35*s*

New edition

Atmospheric Turbulence

O G SUTTON, B.Sc, F R S

Director of the Meteorological Office

(Monographs on Physical Subjects)

With 4 diagrams 2nd edition revised 8*s* 6*d*

METHUEN

MACMILLAN BOOKS

Nuclear Species

H E HUNTLEY, B Sc, Ph D.

University College of the Gold Coast

Although this book is written primarily for the student working for university honours examinations in physics or chemistry, its lucid style should recommend it also to the general reader with scientific training or interests. In it the systematics of the nuclides, set out in order and examined in detail, lead to an up-to-date account of the stability valley of the isotopic chart, the "magic numbers," and other recent developments, including a section on the origin and age of the elements. 21*s.*

Introduction to Factor Analysis

BENJAMIN FRUCHTER

Associate Professor, Department of Educational Psychology, the University of Texas

A great increase in the use of factor-analytic procedures has taken place since the time when Charles Spearman first presented his theory and method of factor analysis This widespread application has created a need for a book such as this which keeps in mind the beginner, yet develops and presents the concepts of factor analysis in a logical order Theory, methods, and techniques are clearly presented by Professor Fruchter in a step-by-step fashion that will have special appeal to those without expert mathematical background, while numerous problems and their answers have been included 37*s* 6*d*

Freedom and Control in Modern Society

Edited by MORROE BERGER, Assistant Professor of Sociology, Princeton University,
THEODORE ABEL, Professor of Sociology, Hunter College,
CHARLES H. PAGE, Professor of Sociology, Smith College

This book was written in honour of Robert Morrison MacIver, one of the great thinkers in the fields of political philosophy and sociology In it scholars who have been his students or colleagues contribute a series of papers bearing on many aspects of the problem· "In a highly organized world how far can freedom go, how close must control be ?" Falling into three general categories—individual freedom in an age of large-scale organization, inter-group relations, and the relation of the individual to his government—some of the most perplexing and controversial topics of our time are illuminated. 45*s.*

Intermediate Chemistry

Sixth Edition

T M. LOWRY, C B E, M.A, D Sc, F.R.S

Late Professor of Chemistry in the University of Cambridge

A C CAVELL, M.A., B.Sc.,

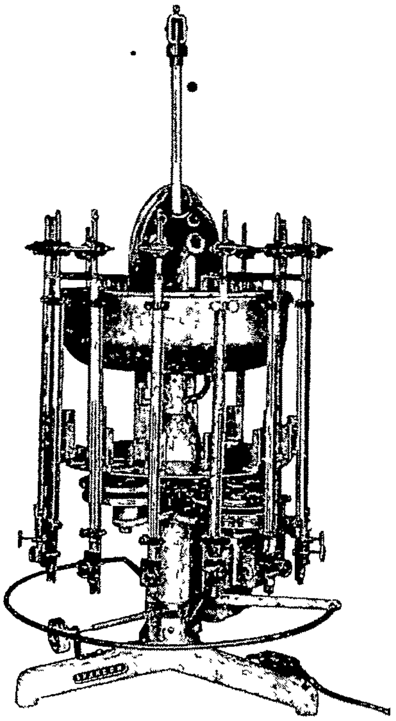
Senior Science Master at Uppingham School

The main intention of this new edition of *Intermediate Chemistry* has been the re-writing of the Organic Section Several changes have been made to the Inorganic Section, and there have also been a number of other alterations to and extensions of the work, which is designed to provide a complete text-book of chemistry for Intermediate and General Certificate (Advanced and Scholarship) Examinations. 18*s.*

All prices are net

St. Martin's Street, London, W.C.2

ROTARY WARBURG APPARATUS



MODEL VB/14

This is the most convenient apparatus for micro-respiration work, its circular shape makes for ease and speed of operation and for economy of space The unit is more compact than a rectangular bath of equal capacity, as it accommodates manometers round its entire periphery The whole apparatus can be rotated around its base, so that any particular manometer can be brought directly in front of the operator, and the apparatus can be installed in any position (in a corner if need be) since only one side need be accessible

The circular shape bath has proved ideal for maintaining a uniform temperature as there are no "dead spots" to hinder circulation Temperature is constant to within ± 0 01°C. Shaking speed and amplitude are adjustable, and provision has been made for secure and positive mounting of the manometers—no wobbling!

SHANDON

SHANDON SCIENTIFIC COMPANY LTD.
6, CROMWELL PLACE, LONDON, S W 7 Tel KNI 1131

WANTED TO PURCHASE

Scientific books & periodicals

Entire libraries, and smaller collections ; sets and runs, foreign and domestic.

WALTER J. JOHNSON, INC.
125 East 23 Street, New York, 10, N.Y., U.S.A.
Cable Address BOOKJOHNS, NEW YORK
British Office: ACADEMIC BOOKS, LTD
129 Queensway, London, W.2

• Individually Tested and Guaranteed •
(A E R E Harwell approved)

HIGH VACUUM STOPCOCKS

New Catalogue on request to

G. SPRINGHAM & CO. Harlow New Town
"The Stopcock People" HARLOW 24108

PHOTOMICROGRAPHY

SIMPL LTD. is fully equipped to undertake all branches of photomicrography for research and industry

Prints, lantern slides, colour prints and transparencies.

SIMPL LIMITED, 1-4 LAMBETH HIGH ST, LONDON, S E 1

H. K. LEWIS & Co. Ltd.

STATIONERY DEPARTMENT. A Comprehensive range of Designers' Sectional Papers, Graph Books and Pads. Sheets and Pads of Logarithmic—"Z" Charts—Circular Percentage—Reciprocal—Triple Co-ordinate —Polar Graph—Time Table (Gantt)—Daily, Weekly and Monthly Charts—Planning Sheets, etc., held in stock.

Catalogues sent on application

H. K. LEWIS & Co. Ltd., 136 Gower Street
Telephone] **LONDON, W.C.1** *[EUSton 4282*

WHELDON & WESLEY, LTD.

Specialists for 100 years in

BIOLOGICAL & GEOLOGICAL BOOKS

Catalogues on Request

•

83/84 BERWICK STREET • LONDON • W.1
Books Bought

The SCIENTIFIC BOOK SUPPLY SERVICE
(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED
Consult us whenever you wish to buy or sell
HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE: CEN. 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

Scientific Circulations Ltd.

We have extensive stocks of Technical Journals, Periodicals and Textbooks. Special terms for Technical and Commercial Libraries. All Scientific and Technical publications purchased.

111, Eastbourne Mews, London, W.2
Telephone: AMBassador 6934

THE MUSEUM BOOK STORE, LTD.
25 Devonshire St., London, W.1
(Welbeck 1340)

Buy and sell Scientific Journals and Periodicals and Learned Society Publications, in all languages. Librarians, and others, should send us their list of "wants", or duplicates for sale.

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?
Suppliers to all Leading Universities, Public Libraries and Institutions of the World. Catalogues issued

★

SELLING?
Specialists in Scientific, Technical Books and Publications of all Learned Societies

★

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephone: *Wel.* 7948; *Amb.* 5991

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

PERGAMON PRESS
242 MARYLEBONE ROAD
LONDON, N.W.1

Forthcoming Books

An Introduction to
The Theory of Numbers
By T. M. VINOGRADOV

An excellent text-book giving a clear exposition of the elementary theory of numbers and containing a remarkable collection of examples and solutions. Translated from the Russian by Dr. H. Popova, University of Aberdeen.

Demy 8*vo* *About* 170 *pages* 12*s*. 6*d*. *net*

This is the first title in a translation programme of recent Russian scientific and technical books. (Additional information on request.)

Proceedings of the Conference on Oxidation Processes
(Amsterdam, 1954)

CONTENTS: Introduction (H. I. Waterman); The mechanism of liquid-phase oxidation (G. H. Twigg); Herstellung synthetischer Fettsaeuren durch Oxidation von paraffinischen Kohlenwasserstoffen mit molekularem Sauerstoff (G. Wietzel); The air oxidation of mixtures of benzene and cyclohexane to phenol (M. B. Donald and J. R. Grover); Oxidations carried out by means of vanadium oxide catalysts (J. Mars and D. W. van Krevelen); Preparation of cumene hydroperoxide (J. P. Fortuin and H. I. Waterman); The development of a process for the manufacture of p-tertiary-butylbenzoic acid (R. M. Cole, A. W. Fairbairn and K. D. Detling); Nitric acid oxidation design in the manufacture of adipic acid from cyclohexanol and cyclohexanone (A. F. Lindsay); The BASF-process for production of acetylene by partial oxidation of gaseous hydrocarbons (E. Bartholomé); Oxygen processes in the steel industry (W. J. B. Chater); The provision of oxygen for industrial processes (F. J. Dent); Closing Address (F. H. Garner).

Demy 4*to* *Paper bound* 136 *pages* 35*s*. *net*

Progress in Nuclear Physics
Volume 4 Edited by O. R. FRISCH

CONTENTS: Photodisintegration Experiments with Nuclear Emulsions (E. W. Titterton); Scintillation Spectrometer Statistics (E. Breitenberger); Meson Phenomena and the Meson Theory (R. H. Dalitz); Focusing in High Energy Accelerators (T. G. Pickavance); Isotopic Spin and Nuclear Reactors (W. E. Burcham); Heavy Ions of High Energy (D. Walker); Nuclear Properties of the Very Heavy Elements (J. O. Newton); Preparation and Chemistry of the Transuranium Elements (H. A. C. McKay and J. Milsted); Neutron Spectroscopy (D. J. Hughes).

Royal 8*vo* *About* 400 *pages* 119 *illus.* 70*s*. *net*

Another
IMPORTANT ANNOUNCEMENT

Griffin & George Ltd have pleasure in announcing that in addition to the facilities offered by their London and Birmingham laboratory furniture factories, they are now associated with Grundy Equipment Ltd in the production of

LABORATORY FURNITURE IN METAL

Inquiries regarding laboratory furniture manufactured in wood or metal will receive prompt attention.

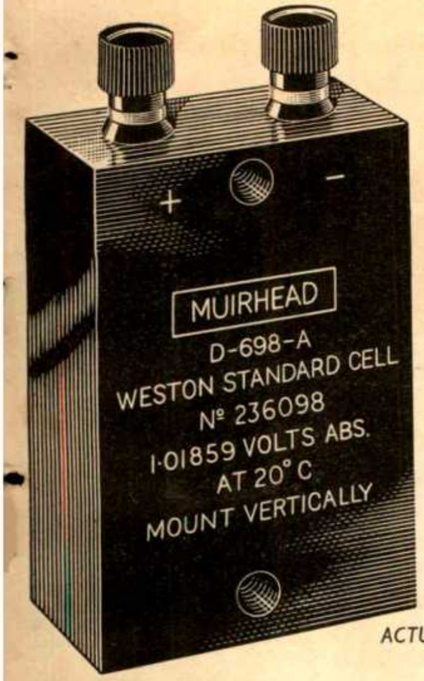
GRIFFIN & GEORGE GROUP

GRIFFIN & TATLOCK DIVISION
London, Manchester, Glasgow & Edinburgh

STANDLEY BELCHER & MASON DIVISION
Birmingham

W & J GEORGE & BECKER DIVISION
Alperton (Middlesex) & Birmingham

REGISTERED OFFICE · KEMBLE STREET · KINGSWAY · LONDON W.C.2



ACTUAL SIZE

A New Standard Cell
by
MUIRHEAD

£3.0.0

Post free in U.K.

D-698 WESTON STANDARD CELL

This new cell combines the robustness and small size of our D-550 Miniature Standard Cell with a high capacity previously only obtainable in larger and more expensive types such as our D-402.

Whether you require a standard of E.M.F. for an industrial application or for laboratory use, this new cell will meet your needs and give many years of reliable service.

SPECIFICATION

E.M.F.	$1.01859\text{V} + 110\mu\text{V} - 90\mu\text{V}$ at 20°C.
Temperature coefficient	-0.00004 per °C.
Discharge rate	Up to $20\mu\text{A}$ for short periods
Internal resistance	600 ohms
Overall dimensions	$1\frac{15}{16}''$ x $1''$ x $3\frac{3}{8}''$
Weight	4 oz.

Our D-550-A and D-402 Weston Standard Cells are still available

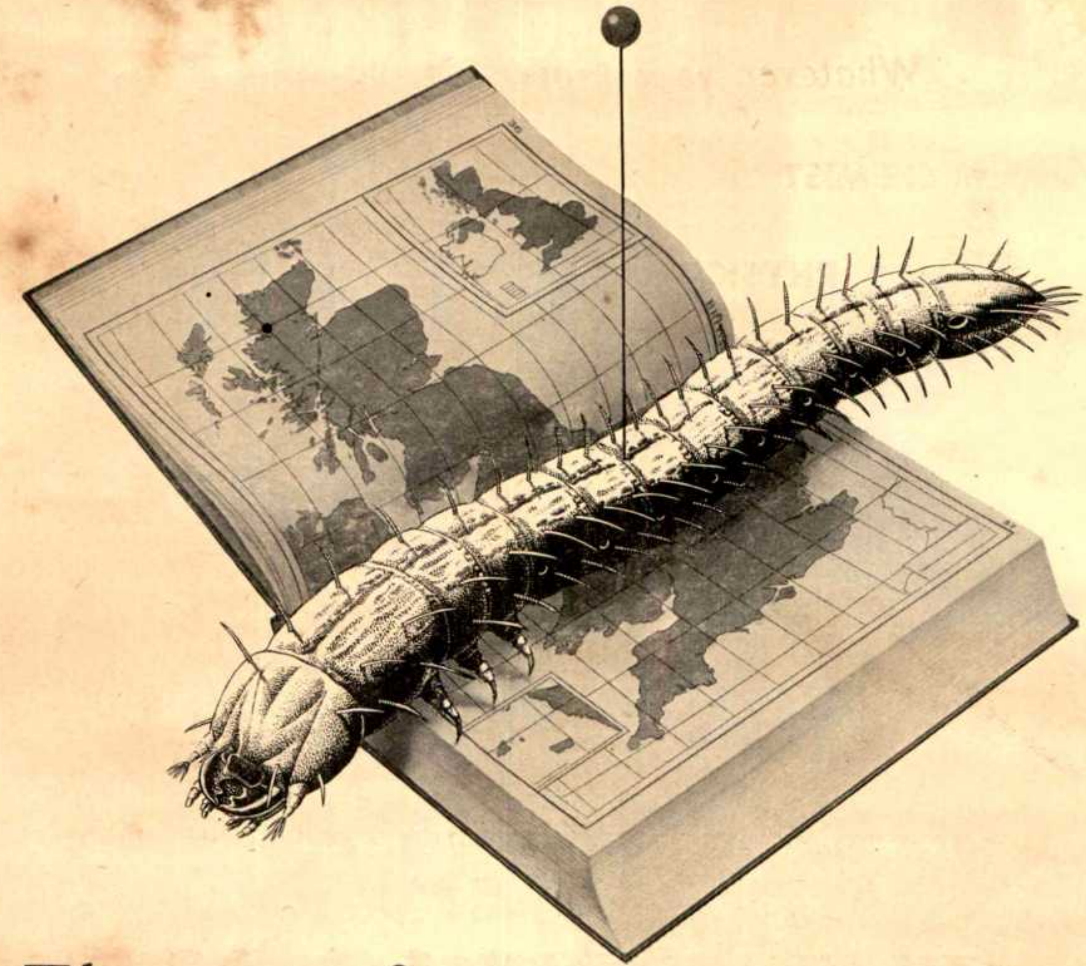
MUIRHEAD

PRECISION ELECTRICAL INSTRUMENTS

WRITE UNDER YOUR BUSINESS
LETTERHEAD FOR
PUBLICATION• 5716

138

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND



The case of *Agriotes obscurus* . . .

Wherever potatoes are grown, wireworms are pretty certain to be encountered and to damage the tubers. In the U.K., for example, this destructive pest populates the soil in some areas to the extent of over a million per acre. In heavy local infestations this figure is probably doubled. Damage fluctuates, but it is nothing unusual to find over half a crop unfit for the table.

With wireworms on the increase, British farmers have welcomed the arrival of aldrin. This year in the United Kingdom alone over 90,000 acres of potatoes will be protected, mostly with aldrinised fertilizer. This Shell insecticide is the most impressive destroyer yet discovered for pests in the soil—non-tainting and exceptionally suitable for compounding with fertilizer.

Just 2½ lbs. of aldrin per acre guards potatoes from wireworm and other soil pests right through the growing season.

Aldrin is fast becoming recognised as being the best of all soil insecticides. A little goes a long way and lasts a long time. Now in world wide use, aldrin gives full control of many pests previously difficult to 'get at' economically.

Another recently developed Shell insecticide is dieldrin *possessing exceptional persistence. On foliage,* dieldrin *controls a very wide range of weevils, beetles, flies and other crop-eating insects. It is also extensively used as a residual spray against disease-carrying insects.*

Have you a stubborn pest problem to be solved?

aldrin

aldrin and dieldrin are SHELL insecticides for world wide use

For further information apply to your Shell Company

Issued by The Shell Petroleum Company Limited, London, E.C.3, England.

Whatever your profession, be it —

- **CHEMIST**
- **PHYSICIST**
- **PATHOLOGIST**
- **METALLURGIST**
- **BOTANIST**
- **ZOOLOGIST**
- **BIOCHEMIST**

you are bound to use a filter paper some time — make sure that it is labelled

WHATMAN

A WIDE RANGE OF PAPERS IS AVAILABLE FOR ALL LABORATORY FILTRATIONS AS WELL AS CHROMATOGRAPHIC AND ELECTROPHORETIC TECHNIQUES

Sole Mill Representatives —

H. REEVE ANGEL & CO. LTD., 9 BRIDEWELL PLACE, LONDON, E.C.4

Made by —

W. & R. BALSTON LTD., MAIDSTONE, KENT

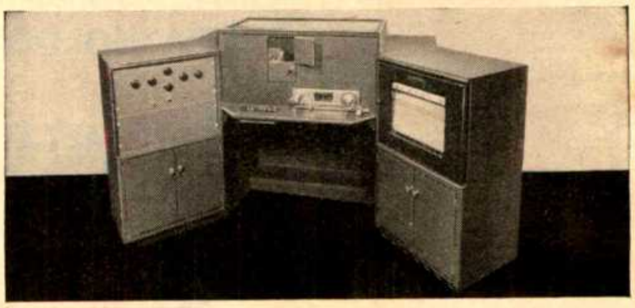
SPECTROSCOPY
BOTTLED HYDROGEN
PACKING CABINETS

is WATER VAPOUR

UNDESIRABLE IN RESEARCH OR PRODUCTION

Both production and research operations often require rigidly controlled humidities to preserve materials, safeguard chemical analyses or simulate ultra-dry conditions. For these small-scale operations, the Birlec Lab Lectrodryer, delivering 100 cu. ft. hr., maintains dew-points down to minus 70°C. Both atmospheric and high pressure models are available. *The coupon below will bring you further information about Lectrodryers and a pocket-size data card, giving HUMIDITY TABLES from — 70°C. to 40°C: you will find both useful.*

Two Lab Lectrodryers (atmospheric pressure models) providing dried air to the spectrometer shown right. (Photographs by courtesy of Pilkington Brothers Ltd.)

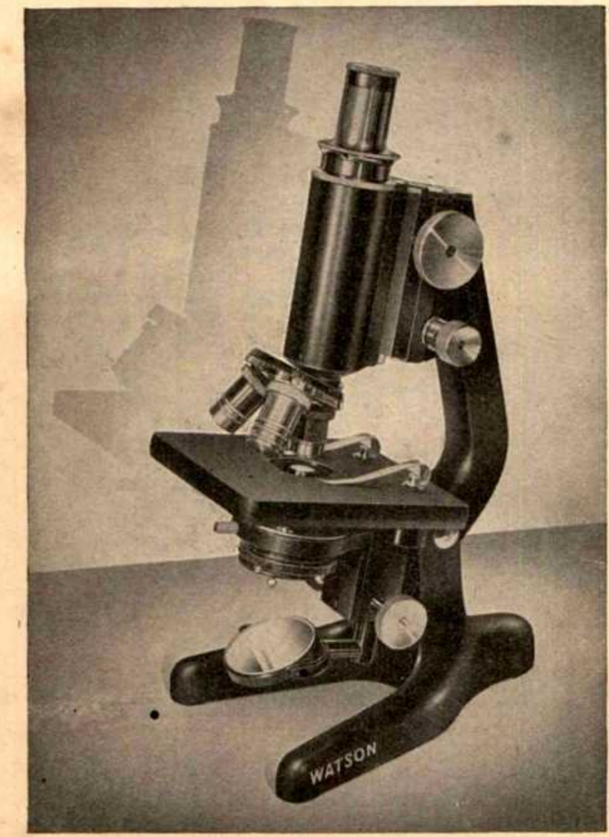


I would like further details about Lectrodryers
NAME...
COMPANY ....
....
....
SBP

DRYER DIVISION OF
BIRLEC LTD

TYBURN ROAD
BIRMINGHAM 24

Member of the A.E.I. Group of Companies



MICROSCOPES

THE "SERVICE II" MICROSCOPE

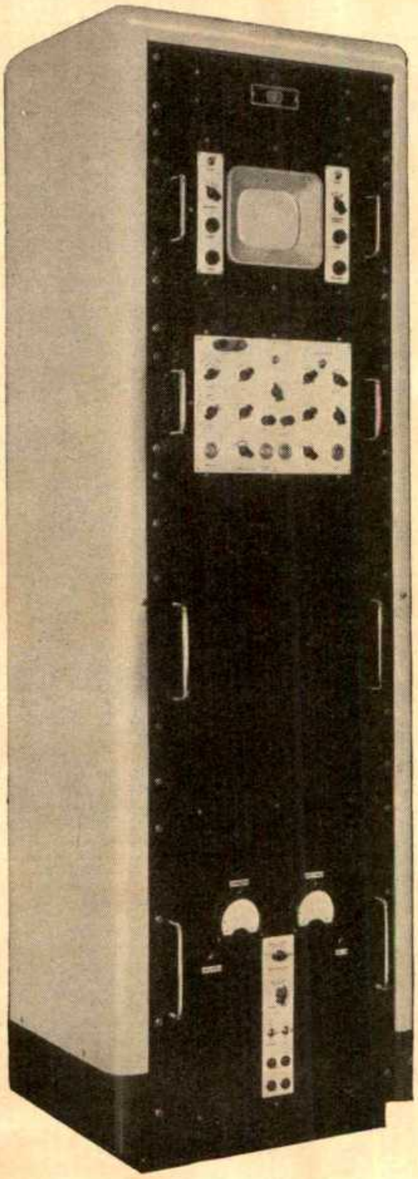
meets the exacting requirements of the student or technician. Its excellent construction and performance are worthy of the Watson tradition.

Write for List 3A.

WATSON'S

W. WATSON & SONS LTD · 313, HIGH HOLBORN, LONDON, W.C.1.

PROGRESS IN CONTROL



SUNVIC
PULSE HEIGHT
ANALYSER

An instrument for the analysis of a complex pulse amplitude spectrum into groups of known height according to their voltage amplitude.

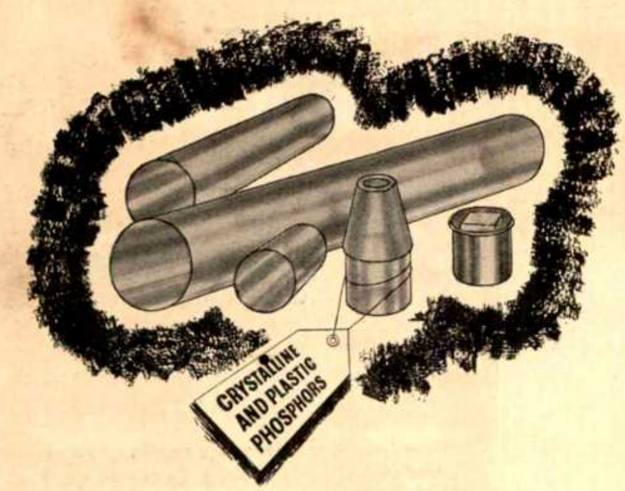
It displays up to a maximum of 120 channels and can store 1,200 binary digits. The design is based on that of Hutchinson & Scarrott (*Phil. Mag.*, 42, 792, 1951) and the instrument is made under licence from the N.R.D.C.

EQUIPMENT BY SUNVIC

SUNVIC CONTROLS LTD. (Special Products Division), No. 1 Factory, Eastern Industrial Estate, Harlow, Essex. Telephone: Harlow 24231/5

Manufacturers of Pneumatic and Electrical Instruments for detection, measurement, control and recording of Temperature, Flow, Liquid Level, Specific Gravity and Pressure, in Science and Industry. Vacuum Pumping and Measuring Equipment, etc.
Member of the A.E.I. Group of Companies.

TAS/Sc.305



Scintillators

'PAMELON'

The NEW I.D.L. high activity plastic scintillator

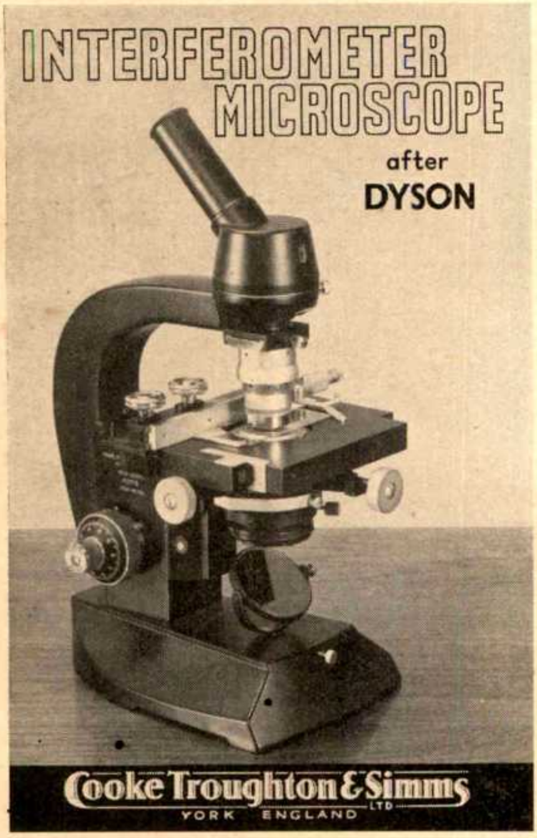
High energy yield with fast decay time and good optical characteristics, ensures equivalent effectiveness to many crystalline phosphors.

Available in large bulk and sections suitable for Alpha, Beta and Gamma rays and X-rays. Easy to fabricate and polish. Stable at low temperatures and pressures.

Pamelon is one of our wide range of scintillators which includes SODIUM IODIDE CAPSULES, HORNYAK BUTTONS, ZINC AND CADMIUM SULPHIDE.

Full particulars from: **ISOTOPE DEVELOPMENTS LTD.**

Laboratory & Works: Beenham Grange, Aldermaston Wharf, nr. Reading, Berks.
London Sales Office: 120, Moorgate, London, E.C.2.
Telephone: METropolitan 9641 (5 lines)



Cooke Troughton & Simms LTD
YORK ENGLAND

HARRINGTON BROS. LTD.
4 OLIVER'S YARD, 53a CITY ROAD, LONDON, E.C.1
Telephone: Clerkenwell 3807 (2 lines)
Telegrams: "Siccative, Ave, London"
LABORATORY CHEMICALS
Specialists in the supply of Organic and Inorganic Chemicals for use in SCHOOL LABORATORIES. Reagents, Indicators and Volumetric Solutions, Stains and other Materials for Microscopy
Catalogue sent on request

◄ ◄ ◄ ◄ **GRATICULES**

We are now using so many modern methods of processing scales, masks and other graticules on glass that we can find a solution to most glass engraving and printing problems.

PATON HAWKSLEY
ROCKHILL LABORATORIES, KEYNSHAM, SOMERSET
Offices: 389 Archway Rd., London, N.6. KEYNSHAM 2364

Secondhand Microscopes
BOUGHT FOR CASH OR TAKEN IN EXCHANGE
CLARKSON'S 338 High Holborn, W.C.1
Opposite Gray's Inn Road 'Phone: HOLborn 2149

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE
FROM LIVER OR YEAST
and other SIGMA brand products are now available.
Ask for list SIGMA 8.
GEORGE T. GURR LTD.
136-138 NEW KINGS RD., LONDON, S.W.6
The Microscopical Stain People

MODERN LABORATORIES

. . . individually planned and designed for their particular purposes. Over half a century of widespread experience of different types of Laboratories enables us to offer suggestions and designs based on the best of present-day developments.

Our Technical Department is always available for free consultation and advice.

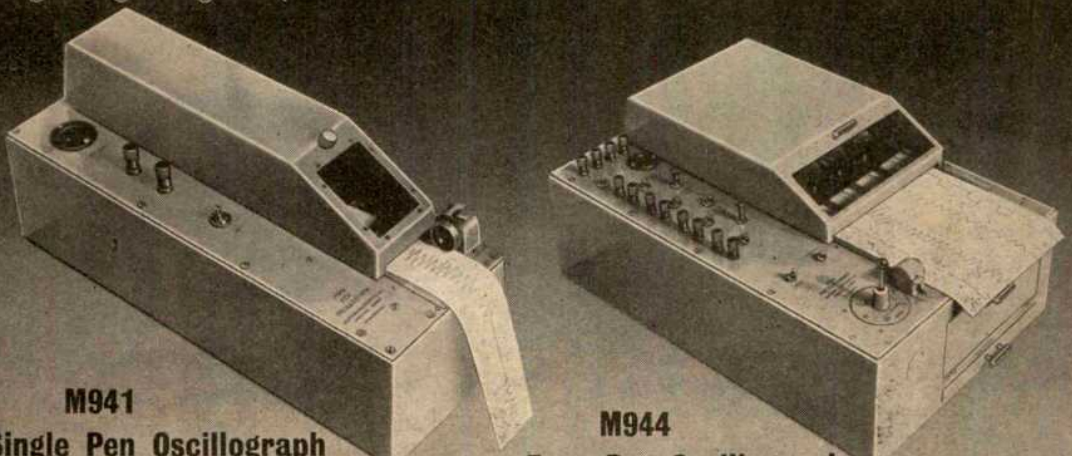
Some Laboratories recently equipped by us:
Production . . . . J. Lyons & Co. Ltd.
Routine . . . . Express Dairy Co. Ltd.
Research, Routine, etc. . . . Glaxo Laboratories Ltd.
Chemical . . . . . . University College, London

With acknowledgments to Glaxo Laboratories Ltd.

CHARLES HEARSON & COMPA
LIMITE

58 WILLOW WALK, BERMONDSEY, LONDON, S.E.1. (BER. 4494—4 lines)

MINIRACK PEN OSCILLOGRAPHS



M941
Single Pen Oscillograph
Please write for leaflet

M944
Four Pen Oscillograph

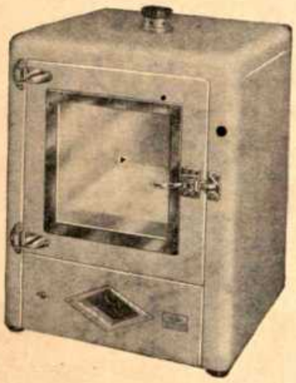
SOUTHERN INSTRUMENTS LIMITED
CAMBERLEY SURREY

Telephone: Camberley 2230 (3 lines) Telegraphic Address: "Minrak, Camberley, England"

Type F *(With or Without forced circulation)*

Hot Air Oven

and Steriliser



STOCKED IN 3 SIZES

All standard LTE equipment is available for one month on test approval . . .

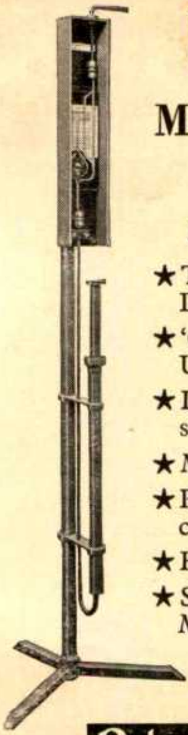
Other LTE Products—

Incubators.
Universal Baths.
Soxhlet Heaters.
Thermostatic Baths.
Dyepot Baths.
Brewer's Mash Baths.
"PATRA" Humidity Cabinet.

Illustration on request to:

ABORATORY THERMAL EQUIPMENT LTD.

GREENFIELD, NR. OLDHAM, ENGLAND
Telephone: Saddleworth 552



Pulsometer

Trade Mark

McLEOD GAUGE
TYPE "G"
with
REPLACEABLE HEAD

- ★ The only breakable part is the Demountable standard Head.
- ★ 'O' Ring Sealed Vacuum Unions.
- ★ Lightweight but rigid construction. All Metal Frame.
- ★ Metal Barometric Tube.
- ★ Plunger operated giving fine control and easy operation.
- ★ Hard Gloss Finish.
- ★ Standard Ranges: .1—.00001 M/M. 10—.01 M/M.

Advertisement No. 3370.

Pulsometer Engineering Co. Ltd.,
Nine Elms Ironworks, Reading.

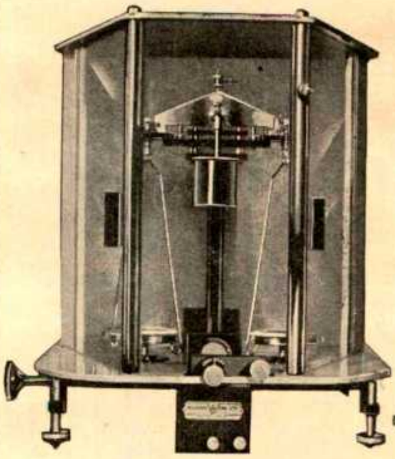
CARL ZEISS

ZEISS LOUPES

These world-famous magnifiers which set the standard many years ago are now being manufactured in their Winkel factory. They are achromatic and aplanatic, mounted in black folding plastic covers, and they are available singly in magnifications of 6×, 8×, and 10×, at £2 4s. each; and in the double folding form 3× and 6× which used together give 9× at £3 10s. each.

RAYNER

100 NEW BOND STREET, LONDON, W.1
Telephone GRO 5081



The new Aperiodic Balance, using **FLUID** Damping.

✦

Fast, Positive Settlement.

✦

Metal case of modern design.

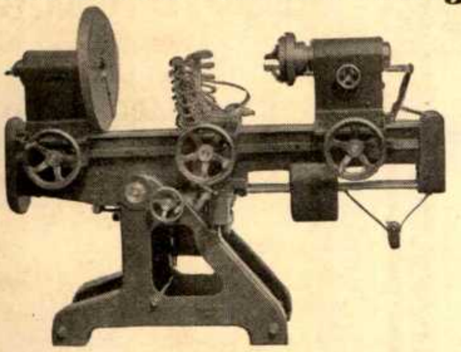
Ask for particulars of the
"CRESTA I"
Aperiodic Balance.

Sole manufacturers:

WILLIAM A. WEBB, LTD.
1-9 PERRYMANS FARM ROAD
NEWBURY PARK, ILFORD, ESSEX
who will gladly send details on request

Phone: VALentine 6370
Grams: Accuracy, Ilford
Cables: Accuracy, Ilford

Universal Glass Working Lathe Mounted Horizontally



This machine can be raised into the vertical position in the matter of a few moments.

There are five models to choose from. May we send you leaflets?

Heathway
Machinery Co., Ltd.
Uxbridge Road, Hillingdon, Middlesex.
Telephone: Uxbridge 6345.

SINGER
Micromanipulators

Singer (High-power) Micromanipulators are suitable for use under magnifications of from × 100 to × 1,000 diameters *plus*, as described by Barer and Saunders-Singer in the *Quarterly Journal of Microscopical Science*, Vol. 89, pp. 439-447, December, 1948.

Singer Microdissectors (Low-power Micromanipulators) are suitable for use under magnifications of from 1 to ×200 diameters and are described by Barer and Saunders-Singer in the *Journal of Scientific Instruments*, Vol. 28, pp. 65-68, March 1951.

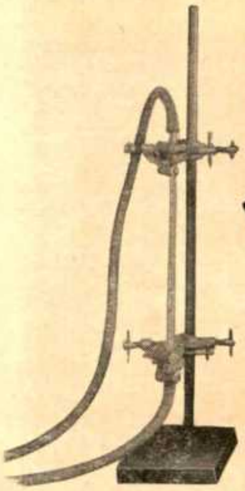
•

SINGER INSTRUMENT COMPANY LTD.
83, London Street, Reading

Measuring

Rate of flow

in research and industry



Type 100
Tube and float only, for laboratory use

FROM
Simple and accurate direct-reading Glass Tube Rotameters

Type 472
Industrial Rotameter for 8 in. pipe. Transmitting unit provides air signal to controller

TO
Complete flow control equipment employing air-operated valve, power cylinder or electric motor speed regulator

Write for Catalogue RP2000/N which gives full details of the Rotameter range of flowmeters.

ROTAMETER

INSTRUMENTS FOR LIQUID AND GAS FLOW MEASUREMENT AND CONTROL

ROTAMETER MANUFACTURING COMPANY LIMITED
602 PURLEY WAY • CROYDON • SURREY
Telephone: CROydon 3816/9

DG/G15

For

Colorimetric

Analysis

use the Biochem Absorptiometer

★ Quick and simple to use.

★ Rapid direct readings of high accuracy.

★ Special low capacity cells (1—7 ml.) now available.

★ Disc of 8 emulsion filters for all tests including Vitamin A and carotene.

★ Mount for test tubes optically compensated so that readings are not affected by refractive indices of solutions.

★ Mains or battery models can be supplied.

★ Built-in constant voltage transformer ensures consistent operation.

★ For use on 100–125 or 200–250 volts, 50–60 c.p.s.

Please write for Catalogue CH 379 (N.1) *for full information.*

HILGER & WATTS LTD : HILGER DIVISION
98 St. Pancras Way, Camden Road, London, N.W.1, England

Member of the Scientific Instrument Manufacturers' Association and of SCIEX.

Bottom Water, for example, as about 1 cm./sec., so that it would take about twenty years to travel from the Antarctic to the Equator. Estimates by carbon-14 dating technique, however, have given a time as long as eighteen hundred years, while photographs of sand ripples have suggested currents greater than 15 cm./sec. at the bottom. The direct measurements which have been made to date have been in some cases in agreement and in others in disagreement with the estimates. The difficulties of using a current meter from an anchored ship lead to possible errors of measurement which may, in some cases, be comparable with the deep currents themselves. New methods and techniques, some examples of which were given by subsequent speakers, are needed in the study of deep currents.

The next two papers were of a theoretical character, and both were concerned with currents due directly or indirectly to the stress of the wind on the sea surface. Dr. E. T. Eady (Imperial College of Science and Technology, London) gave a critical account of recent theories of the wind-driven large-scale circulations, which have shown that the concentration of flow towards the western sides of the oceans arises as a consequence of the variation of the vertical component of the earth's rotation with latitude. The basis of such theories, as developed by Stommel and Munk, is the integrated vorticity equation, from which it may be inferred that, in a steady state and in the absence of stresses on the 'sides' of a vertical column of water due to turbulent motion, the mean north–south motion of the column is proportional to the external torque, presumably due almost entirely to wind stresses on the surface of the ocean. The reason is that the rate of (absolute) rotation of the column must be almost the same as the vertical component of the earth's rotation, and this increases with latitude. Since the external torque is mainly a function of latitude and all the water cannot move north or south, it is necessary to assume that short-range turbulent stresses play an important part in a narrow region on the western side of the ocean, where there is a strong narrow current in the opposite direction to the drift elsewhere. A difficulty in interpretation is that we do not know the mean currents, measurements of density gradient yielding only relative currents. As a step towards a more detailed theory, Dr. Eady showed that, if we suppose that the turbulent motion which transmits the surface stresses downwards is limited to a rather shallow layer, then there must be convergence in this layer near latitude 30° which forces down the light surface water. There are, however, difficulties in applying such a simple theory in low latitudes.

Dr. W. V. R. Malkus (Woods Hole Oceanographic Institution, U.S.A.) gave an account of a treatment representing an extension of work by H. Stommel, which was based on the assumption of a two-layer ocean, considering particularly its application to the Gulf Stream. The two layers, of different temperatures, and hence of different densities, are separated by an interface of variable depth which meets the surface in a line corresponding to the cold northern edge of the Gulf Stream. The surface layer is assumed to be in geostrophic balance and its vorticity conserved. Dr. Malkus gave a solution for the depth of the upper layer as a function of latitude and the transport by the current in the upper layer for a given distribution of wind stress. He suggested that momentum is lost from the Gulf Stream by eddies which break off from the meanders, the momentum being dissipated in the cold water to the north of the current and the heat lost by radiation and evaporation to the atmosphere. Assuming that half the momentum of the Gulf Stream is lost in this way, and taking the appropriate temperatures for the two layers, a reasonable solution may be obtained for the loss of heat energy and for the depth of the interface. For a transport corresponding to the wind stress curl as observed, the maximum depth is 800 m. Dr. Malkus suggested further that the water lost from the surface layer in this way returns as a deep current, with a velocity which would be about $\frac{1}{8}$ cm./sec. if distributed over 3,000 m. of depth. This might be re-incorporated in the surface layer in lower latitudes by the deepening of the thermocline by about 50 m., which occurs in the winter months.

Mr. T. V. Davies (King's College, London) dealt with a possible experimental approach on the model scale, referring to the 'dish pan' experiments of Fultz in Chicago and Hide in Cambridge, which were designed to study motions in the atmosphere on the rotating earth. In the experiments, a liquid is contained in the annular space between two concentric cylinders, which are rotated about their common axis. Heat is supplied at the outer boundary while the inner boundary is cooled, corresponding to the heating of the atmosphere in the equatorial region and cooling near the poles. The flow régime depends, other things being equal, on the angular velocity of rotation. For low rates of rotation, the water particles rise near the outer boundary, move inwards near the surface, sink near the inner boundary and flow outwards below in a uniform manner. This has been called the 'Hadley régime'. When the rate of rotation exceeds a critical value, another system of flow, known as the 'Rossby régime', sets in, in which the surface flow becomes concentrated into wave-like paths, similar to the 'jet streams' which occur in the upper atmosphere. Mr. Davies presented the theory on which these experiments are based, starting from the equations of motion, continuity and heat transfer, and arriving at three parameters governing the motion, by which the transformation from model to full-scale flow should be carried out. The values of these parameters for the ocean are of the order of a hundredth of those for the atmosphere, but they should be within the range readily attainable in experiments. The type of motion studied hitherto derives its energy from thermodynamic processes, which are predominant in the atmosphere. Mr. Davies pointed out that the surface stresses, which are important in the case of the oceans, have not been represented, but suggested that they might be included by using two layers of liquid in the experiments.

In the last contribution, Mr. J. Crease (National Institute of Oceanography) returned to full-scale observations in the ocean, describing some results obtained by three different methods during last May and June in R.R.S. *Discovery II*, working in an area between Spain and the Azores, about 42½° N., 20½° W., in a depth of about 4,000 m. In the first method, a deep drogue constructed of two steel frames 6 ft. square, in the form of a cross, and covered with canvas, was suspended by piano wire from a pair of small elliptical floats. Two such drogues, one at 1,000 m. and the other at 2,000 m., were tracked for several days, their positions being fixed by radar from the ship, relative to a marker buoy moored by piano wire to a sinker on the bottom. Both indicated a flow directed approximately towards the east-north-east, the drogue at 1,000 m. averaging about 0·2 knot (about 10 cm./sec.) and that at 2,000 m. about 0·1 knot. The second method consisted of taking normal hydrographic stations down to 3,000 m. at the four corners of a square of 10 miles side, and computing the velocity perpendicular to each side of the square relative to that at 3,000 m. The results indicated an apparent flow into the square across one pair of opposite sides and outwards across the other pair of sides. Mr. Crease suggested that this surprising result might be due to tidal changes in the slopes of the isobaric surfaces, the whole four stations having been occupied in a period of a little more than twelve hours. The third method employed a new technique, analogous to the use of an inverted radiosonde. A supersonic transmitter, emitting a 'ping' every few seconds, was attached to a type of parachute, so that it sank slowly through the water at a rate of about 250 m./hr. Its position was fixed at intervals by sound-ranging, the pings being received by four hydrophones, one suspended below the ship and the other three below sono-radio buoys, which were moored to the bottom by piano wire, and which transmitted the received signals to the ship. The relative positions of the buoys and the ship were fixed by radar. The results showed a current in the same direction as that indicated by the drogues, but of a greater magnitude: about 0·5 knot down to 1,200 m. and decreasing at greater depths.

The discussion which followed reflected the interest aroused in the new theoretical and experimental approaches. In reply to suggestions on the sinking transmitter technique, Mr. Crease said that the design of a transmitter which would remain for a long period at a constant depth was being considered. Reference was made to the rotating model experiments of Von Arx at Woods Hole, Massachusetts, in which a basin of paraboloidal shape is used, providing for the variation of Coriolis parameter with latitude, and boundaries having the outlines of the actual ocean boundaries in the northern hemisphere are inserted. Air streams over the model simulate the atmospheric wind systems, so that these experiments are a study of the wind-driven ocean circulation and in a sense are complementary to the 'dish pan' experiments, which have been concerned with circulations arising from processes of heating and cooling. While much remains to be learned about deep-water movements and the part they play in the general oceanic circulation, it is clear that the subject is being attacked vigorously from several angles and that encouraging progress is being made.

K. F. BOWDEN

LABORATORY ANIMALS IN THE UNITED STATES

"THE need for adequate standards and methods in the procurement of biological materials for research, assaying, testing and teaching"—to quote Dr. Orson N. Eaton—has been recognized for many years. The biological materials referred to are laboratory animals, and the need has, since the Second World War, become pressing in nearly every country in the world. The first action on a national scale was taken by the British Medical Research Council, which set up the Laboratory Animals Bureau in 1947. Five years later, in 1952, the Division of Biology and Agriculture of the American National Research Council, in consultation with government, university and industrial representatives, created an Institute of Animal Resources, and appointed Dr. Eaton as its executive secretary.

This was not the first American organization to make its main purpose the study of problems connected with laboratory animals. In 1950 a private and voluntary group of veterinarians and others interested in the provision and use of animals for scientific work formed an Animal Care Panel. This Panel has met every year from 1950 onwards for the purpose of receiving communications from its members, and these communications, together with the inevitable and stimulating discussions, are reproduced as proceedings. The proceedings are circulated only to members of the Panel, which is unfortunate, for much of their contents deserves wider publication; but the financial resources of the group are limited, and wider publication would presumably be beyond them.

There was a need, therefore, for the Institute of Animal Resources, with its official backing, both moral and material, and the choice of a distinguished geneticist as its executive secretary was a good one. All problems relating to laboratory animals are not genetical, and the Board of the Institute represents many other interests; but as the work of the Institute progresses, genetics will become increasingly important, and it is well that such developments can be expertly anticipated.

The work of the Institute is complementary to that of the Animal Care Panel, and since one finds that many names on the Board of one are among the membership of the other, close collaboration between the two can be assured. In addition to Dr. Eaton as executive secretary, the membership of the Executive Board of the Institute is made up as follows: P. B. Armstrong, Marine Biological Laboratory, Woods Hole; N. R. Brewer, Central Animal Quarters, University of Chicago; T. C. Byerly, U.S. Department of Agriculture; G. B. Coursen, General Biological Supply House, Chicago; A. E. Earl, Ciba Pharmaceutical Products; H. G. Herrlein, Rockland Farms; G. E. Jay, jun., National Institutes of Health; D. Jenkins, Chemical Corps Biological Laboratories; G. W. Kidder, Amherst College; C. G. King, Nutrition Foundation; W. Landauer, University of Connecticut; C. C. Little, Jackson Memorial Laboratory; R. C. Percival, Lederle Laboratories; and C. A. Slanetz, College of Physicians and Surgeons, Columbia University.

The aims of the Institute are: (1) to survey and list existing sources of animal stocks used in biological (including agricultural, medical and industrial) research, testing and assaying; and to determine the consumers and the volume of demand for such material; (2) to perpetuate this activity by taking periodic inventories and keeping a live master registry of those sources, for distribution to all interested persons and groups of consumers (for example, research laboratories, academic institutions, government agencies, industrial and trade establishments, etc.); (3) to promulgate scientific standards of definition, terminology and tolerated variability in regard to genetic constitution, nutrition, freedom from disease, housing conditions and maintenance for the major groups of animals in use; (4) to act as a liaison centre on information regarding the detection, preservation and perpetuation of new or old strains of special importance for specific problems (for example, cancer); (5) to devise measures for ensuring adequate supplies of needed animal stocks in states of emergency (war, epidemics, etc.); and (6) to assist in the organization and facilitation of the international exchange of needed animal stocks.

The first publication of the Institute is a "Handbook of Laboratory Animals"[*]. This handbook has a page on genetics, by Dr. George E. Jay, jun.; a page and a half on nutrition, by Dr. Charles A. Slanetz; a page on diseases of laboratory animals, by Dr. N. R. Brewer, followed by twelve pages summarizing the more common infections of a wide variety of species; an extensive table of sources of animal supply; three pages on the uses of laboratory animals, with an extensive bibliography of uses; a short selection of general references; a table of users of laboratory animals; and a brief note on the importance and desirability of international exchange, both of information and of strains of animals of particular interest, which we in Great Britain can whole-heartedly endorse.

The main part of the handbook is occupied by the two tables, which have been compiled from the answers to questionnaires sent out by the Institute. The table of sources of animal supply is subdivided by species, and covers mice, rats, guinea pigs, rabbits, hamsters, dogs, monkeys, chicks and a wide variety of miscellaneous animals. There are columns showing strain, original source, breeding system, description, diet, disease control measures, uses and productive output, against each source of supply, which includes both laboratories and commercial breeders and suppliers. Although this list is far from complete for the country as a whole, and probably represents only a minority of total sources, it is formidable, and will undoubtedly be an immensely useful catalogue for any scientific worker wishing to select the most suitable animals for his researches. The tabulation is clear, and most of the information essentially useful. (A counterpart of this table is the "Laboratory Animals Bureau Catalogue of Uniform Strains maintained in Great Britain".) Further additions to the table have been promised, and any approach towards comprehensiveness will certainly enhance its value.

The list of uses of laboratory animals is certainly very incomplete, but, taken in conjunction with the table of sources, is a worth-while guide. Its expansion in subsequent issues would make it a useful reference index.

The second table, listing users of laboratory animals, contains information essential to the functioning of the Institute, but it is harder to see what interest it can have for others. Had it been necessary to show that the Institute was in fact well occupied, its inclusion in the handbook might have been justified, but the rest of the handbook is already sufficient evidence.

Such criticism of the Institute's work may appear ungenerous, but this would be a false impression. The Institute has undertaken a task, both of urgent necessity and of a complexity incomparably greater than in Great Britain, where the numbers of laboratories, of scientific workers and of animals used are so much smaller. It has tackled the problem with the vigour to be expected of our American colleagues, and the handbook, produced within two years of the establishment of the Institute, is ample tribute to its competence and industry. Only one who has faced similar tasks elsewhere can appreciate how much thought and work went into this enterprise, and we look forward with eagerness and confidence to further publications from the same source.

---

[*] Handbook of Laboratory Animals. (Pub. No. 317 of the National Academy of Sciences—National Research Council.) Prepared by the Institute of Animal Resources. Pp. v+77. (Washington, D.C., 1954.) 1.25 dollars.

PROFESSIONAL STATUS OF MANAGEMENT

A WELL-KNOWN management consultant, Colonel L. Urwick, discusses in a small booklet[*] the question as to whether management is or is not regarded as a profession, and puts forward the view that the problem is not wholly academic or a matter of words. It can have considerable influence on such questions as whether or not during the next few years Britain will be able to pay its debts or must face a falling standard of life for its people. All that is necessary to establish the claim of management to professional status is to prove that it involves some branch of learning; in other words, that there is a body of knowledge bearing on the activity of management which can be taught and learned. In 1951 there were nearly seven hundred educational institutions in the United States awarding degrees at university standard in management subjects; the number of university students 'majoring' in this field was more than 370,000, and just over eighty thousand degrees were awarded.

In Great Britain the figures were proportionately much smaller; but a number of universities have degree courses in management. An intermediate examination in management subjects has been established, and it is national policy that technical colleges should provide facilities for those who wish to prepare for it. If there is no body of knowledge bearing on management which can be taught and learned, all these activities are meaningless. On what then, asks Colonel Urwick, is the resistance to this conclusion among certain business men founded? The suggestion that management is becoming professionalized seems to many 'practical business men' to threaten with the 'theorizing' that they so much dislike the very area which they had previously regarded as the special citadel of practicality. Secondly, many men in responsible positions to-day are wholly innocent of any formal preparation for their tasks. They have learned the technique and customs of their particular trade or industry by 'experience'.

It is always difficult for the individual to resist the conclusion that the process which launched his peculiar abilities upon the community was wisely conceived. The tendency to become *laudator temporis acti* and exaggerated loyalty to 'the old school' have similar roots in the eternal fidelity of human nature to itself. The very suggestion of new and improved methods of training which will systematize and shorten the acquisition of experience seems to many a direct threat to their personal integrity.

Others again are concerned lest, if young men who have not yet won their spurs are allowed to study the art of management, they will become overimpressed with their own theoretical knowledge. There is some truth in this. Most young men under twenty-five who have had the benefit of a higher education pass through a period when they overestimate the force of logical argument and underestimate the mutability of things It is a condition which the older men of wisdom learn to recognize and to correct with kindly tolerance.

---

[*] Is Management a Profession? By L. Urwick. Pp. 27. (London: Urwick, Orr and Partners, Ltd., 1954.)

Another traditional attitude which plays a part in this picture, curiously at variance with our preference for the 'practical', is the British prejudice in favour of amateurishness In business, being a director is still, in part, a stronghold of the amateur Many men are made directors of companies who have neither worked their way up through the ranks of management nor have qualified themselves professionally in other ways. They often represent important financial interests, which should be represented, but have no knowledge of the art and science of management or of the technique of the particular industry or trade with which the company is concerned To suggest to men who have absorbed this national prejudice in favour of amateurishness that business management should be treated as a profession seems deeply shocking

There are certain historical reasons why the title 'director' in business has become one of the last bastions of this crumbling edifice of social prejudice It is no accident that the highest class in the British Civil Service, that into which university graduates are recruited direct and from which the majority of the highest posts are filled, is known as the Administrative Class The second grade, recruited from secondary-school students, is termed the Executive Class Executive work—that is, management—commands far less social prestige in Great Britain than in the United States, where the greatest elective office in the world, the presidency, is by definition an executive office

The proposition that management should be treated as a profession cuts across many of these quasi-understandings and habitual ways of thinking, some of them with their roots deep in British history It means recognizing the employee, the salaried man with managerial duties, as much less sharply distinguished from the director than has been the case in the past.

Finally, in this order of objections, comes fear In recent years the leaders of business in Great Britain have had an uneasy time The Second World War exposed them to an orgy of government regulation from which they have not yet entirely escaped Men who have been thus harried are bound to be sensitive beyond the normal, to feel that any suggestion that their salaried employees are going to act together—and professional status does connote some form of professional organization which might, however improbably, issue in bargaining conditions—should be resisted at all costs

The objections to regarding management as a profession are all of them subjective They are fears, feelings, folk-ways, customary attitudes, prejudices in favour of, or against, this or that, and the best way to deal with a non-logical impulse or habit of thought which cannot be defended by argument—and any argument in favour of social distinctions is deeply out of sympathy with the spirit of the time—is to ignore it, to push it away below the threshold of consciousness Yet, assuming that the word management is used of the activity normally understood by the word and confined strictly to executive functions, there seems to be no insuperable practical obstacle to the professional organization of those engaged in this occupation

WELDING IN SHIP CONSTRUCTION

During the Second World War a large number of merchant ships were built in the United States, at a rate of production which could only have been achieved with the extensive use of welding In the circumstances, it is not surprising that a proportion of these ships should have suffered structural failure when in service It is now clear that most of the failures were examples of notch brittle fracture, such as has been experienced from time to time in many types of steel structure, both riveted and welded, on land and at sea, ever since iron and steel have been in common use At the time, however, it was widely believed that the welded ships were intrinsically more prone to fracture than their riveted counterparts With a different pattern of production, the British shipbuilding industry was not at that time faced with a similar problem In spite of this, the Admiralty Ship Welding Committee was set up in 1943 with terms of reference, "To consider and investigate special problems arising from the employment of welding in ship's structures and to advise on methods for their solution" This Committee has just been disbanded, and its last report has been issued[*]

Much of the work of the Committee was devoted to metallurgical studies relating to notch brittle fracture, and it is in this direction that the most radical changes have been proposed. Nevertheless, it was necessary to distinguish the differences in structural behaviour, if any should exist, between riveted and welded ships of otherwise identical design The series of trials carried out for this purpose deserve wide recognition for their excellence of planning and execution. Four ships were chosen for the major trials Of these, two were 12,000-ton tankers and two were 10,000-ton dry-cargo ships. The ships of each pair were identical, except for the alternatives of welded and riveted joints In addition to the more obvious differences of design between the tankers and the dry-cargo ships, the former had a preponderance of shell framing in the longitudinal, and the latter in the transverse direction. Although the primary object of the tests was to compare the stress distributions to which the riveted and welded ships would be subjected at sea, it was decided that this could not be undertaken directly. Alternatively, on one only, the welded dry-cargo ship *Ocean Vulcan*, an extensive investigation was made, not only of the forces which North Atlantic sea conditions produced, but also of the stresses and deflexions which similar forces produced when applied in still water by means of ballast loadings The latter were chosen to simulate various vertical and horizontal bending-moment conditions, shear forces and torsion moments The still-water investigations were also carried out for each of the remaining ships

[*] Admiralty Ship Welding Committee Report No R 6 Structural Tests in Still Water on Welded Dry Cargo Ship *Ocean Vulcan* Pp x+50+25 plates+109 diagrams+8 tables 30*s* net Report No R 7 Structural Tests in Still Water on Riveted Dry Cargo Ship *Clan Alpine* Pp x+18+16 plates+116 diagrams+9 tables 30*s* net Report No R 8 S S *Ocean Vulcan* Sea Trials—The Forces Acting on the Ship at Sea Pp viii+175+17 plates 35*s* net Report No R 9 *Ocean Vulcan* Sea Trials—Detailed Analysis of Record No 1 E 3 (Loaded Condition) Pp viii + 17 + 87 diagrams 25*s* net Report No R 10 *Ocean Vulcan* Sea Trials—Detailed Analysis of Record No 6 E 7 (Loaded Condition) Pp viii+200 (187 pages of diagrams) 42*s* net Report No R 11 S S *Ocean Vulcan* Sea Trials Detailed Analysis of Record No 6 W 5 (Ballast Condition) Pp viii+12+124 diagrams 27*s* 6*d* net Report No R 12 Structural Trials on S S *Ocean Vulcan* and S S *Clan Alpine* Discussion of Results (In the press) (London H M Stationery Office, 1953 and 1954)

The confidence with which the results of such investigations may be accepted rests clearly on the independent checks which may be made on each set of readings. In this respect the investigators were particularly successful. In the static trials, close comparisons were possible between measured and calculated stress distributions at the test sections and between measured and calculated deflexions. In the sea trials similar successful comparisons were possible between stress distributions measured at a hull cross-section and those predicted from the forces estimated from water-pressure distributions on the submerged portion of the hull, together with hull acceleration measurements.

In general, none of the results does other than confirm the methods now adopted for calculating necessary hull structural strengths, and dispose of the possibility that any broad difference exists between the structural characteristics of otherwise similar welded and riveted hulls. Nevertheless, many differences of detail are exposed. It is shown, for example, that the shrinkages which take place when welds are deposited along plate edges give rise to initial buckles considerably greater than where riveting is employed, so that bending stresses are increased. Under these conditions, longitudinal framing is particularly effective, since the supporting members are disposed more favourably for the suppression of buckling due to longitudinal compressive loads. It is perhaps unfortunate that this is not stated among the conclusions, although the evidence is clearly given. On the other hand, one may wonder why so much space is devoted to proving that rivet slip is not important in contributing to the deformation under load of riveted hulls.

Some idea of the immensity of the task of computation from the measurements may be grasped by reference to the number of tables and diagrams in the various reports, and it is scarcely surprising that several years elapsed before publication was possible. It is fitting tribute to those concerned in the work that the results may now be so readily assimilated by the reader. A. A. Wells

---

NEW ZEALAND DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR THE YEAR 1953–54

THE twenty-eighth annual report of the Department of Scientific and Industrial Research, New Zealand*, covers the year ended March 31, 1954. Besides the Minister's statement and the Secretary's report, it includes brief, but not technical, reports from the several branches of the Department and the incorporated research associations, and from the Cawthron Institute and the university colleges to which grants were made by the Department; to most of these latter reports a list of publications is appended. The new building for the Grasslands Division at Palmerston North, which is nearing completion, should largely meet the needs of this Division, and new accommodation has been provided at Lower Hutt for three research associations, while the Botany Division is now to be transferred from Wellington to a suitable building at Christchurch. In future, branches of the Department will publish periodic reviews of their work, giving more detail than was possible in those previously included in the Department's annual report; those in the present report merely list the principal projects under way.

The Secretary's report stresses the need for adequate and fireproof accommodation for the Botany Division and Geological Survey; but the additional land acquired at Owairaka should suffice for the needs of the Plant Diseases Division and the Fruit Research Station for many years to come. The Department's activities in oceanography have been reorganized, and increasing attention will be given to marine biology and geology and to studies of the temperature, salinity and movement of water masses in the New Zealand area. Net expenditure of the Department was £1,025,414, compared with £941,723 during 1952–53, and the staff at March 31, 1954, was 937, compared with 931 on April 1, 1953. Only six of forty-two vacancies for which provision was made in the estimates were filled during the year, and the professional staff was unchanged at 374; technical staff numbered 347. Of the total expenditure, 24·7 per cent was for services to other government departments and public bodies, 53 per cent for services (including research) to farming and industry, 9·5 per cent for grants to research associations, university colleges, etc., and 12·8 per cent for administration, information services, and publications. It is also estimated that about 47 per cent of the expenditure is on research and service to farming industries.

In view of the elimination of the technical reports from the various branches previously included, the Secretary's report gives a rather fuller general survey than previous reports. During the year the Soil Bureau published as a bulletin a "General Survey of the Soils of North Island, New Zealand", and preparatory work for the issue of a similar publication for South Island has commenced. A survey has also been commenced of the minor-element status of the major soil types in the Dominion, using sweet vernal grass, which grows throughout New Zealand, to indicate the soil nutrients available to it and thus eliminate the uncertainty of chemical methods of extraction of soils. The extensive investigation of bloat of dairy cows, which was commenced in 1952, indicates to date that bloat is caused by some soluble material or materials with foam-producing properties, and that a study of the physical condition of the rumen contents is the most promising line of investigation. A new strain of cocksfoot, based on plants of New Zealand origin, has now been produced and released under certification after trials which indicate an annual production 18–20 per cent higher than that of *C23*. The new strain has a wider seasonal range of production and begins growth earlier in the spring.

Trials carried out by the Plant Diseases Division in widely separated areas have shown that the establishment of red, white and subterranean clovers can be markedly improved by inoculating the seed with selected efficient strains of nodule bacteria, and an economic but effective method of applying the inoculum to commercial quantities of seed is being sought. The use of commercial insecticide–fertilizer mixtures for the control of grass-grub and *Oxycanus* in pastures by methods worked out by the Entomological Research Station continues to increase during 1952–53, 4,467 tons was used for this purpose compared with 2,109 during 1951–52, and production of DDT-superphosphate during 1953–54 is estimated at 6,200 tons Of about 150 tons of DDT used in the Dominion, 107 tons is used to control these two pests alone, about 20 tons being used for orchard work and 20 tons for fly sprays and other purposes In the Canterbury and Waikato areas alone, grass-grub attack on the 3 5 million acres of pasture is liable to cause an annual loss of £4 million. Attention is being given to particle size, wettability and the distribution of insecticide within a batch of fertilizer The Entomological Research Station's investigation into the roles of *Eriococcus* and the associated fungus in relation to the death of manuka (*Leptospermum scoparium*) continued and also the mapping of the distribution of *Eriococcus*

---

* New Zealand Department of Scientific and Industrial Research. Twenty-eighth Annual Report. Pp. 68. (Wellington Government Printer, 1954.)

Tests of introduced varieties of linseed indicate that Marine, although not yielding as heavily as Golden Viking in a disease-free year, is a more reliable variety for New Zealand owing to its resistance to fungus (Pasmo) and to rust disease, except the rare and weak Race 12 of rust. Steps are being taken to reduce the great variation of type within strains and varieties of commercial vegetable seeds, especially among the Brassicas, by bulk seeding of selected plants, followed by progeny testing and further selection, and lines of savoy cabbage have been developed and characterized by increased percentage of marketable heads and uniformity of type and maturity. A comprehensive bulletin covering present knowledge of plant virus disease in New Zealand, and describing the control of cherry plum mosaic among cuttings grown as stocks, which has been achieved by removing infected plants, was published during the year

Considerable progress was made by the Animal Ecology Section during the year with its analysis of data on reproduction and parasites of rabbits and with other rabbit population studies

The Geophysics Division is conducting a gravity survey which will provide information on the depth of volcanic debris overlaying the basement greywacke and also more detailed surveys of the Waiotapu area, using seismic and gravity methods to elucidate the geological structure, and magnetic and electrical methods to delineate the high-temperature conditions near the surface These surveys will provide the data required for the development of power from geothermal steam, and the Dominion Laboratory has continued and extended observations of the temperature and discharge of hot springs, the periods of geysers, etc Officers from this Laboratory and the Dominion Physical Laboratory have developed the technique of radiocarbon dating of carbonaceous materials for use in New Zealand, and a number of the ash showers blanketing a large part of the centre of the North Island have already been dated

In the Dominion Laboratory a small team has developed a process of drying meat in slices up to half an inch thick, in which the slices of frozen meat are submerged in melted fat at 140–160° F (60–71 1° C) and the moisture extracted under vacuum Satisfactory material has been obtained from both beef and mutton in pilot-plant trials and were tested by Sir Edmund Hillary on his recent Himalayan expedition. Flour testing and reporting procedures at the Wheat Research Institute have been improved, and experimental studies of baking processes continued Large reserves of coal in the Maramarua area for possible steam-electric generation were proved by the Geological Survey in co-operation with the Mines Department The Department is now responsible for the annual preparation of charts showing the magnetic variation of the compass for an extensive area of the south-west Pacific, and the shipping companies and Royal New Zealand Navy are co-operating in a programme to determine the chart error at about thirty selected points. Large-scale tests of promising pozzolanic materials for constructional purposes have been made at the Dominion Physical Laboratory Some eighty per cent of the original recommended range of standards equipment has now been received, including a Diesselhorst thermo-electric free potentiometer for temperature measurement and the first of a range of precision balances for calibrating weights, and an electron microscope which is in constant use. Full-scale field trials by the Extension Division of the Department of Agriculture indicate that the process for the production of fused calcium–magnesium phosphate from New Zealand olivine rocks, developed by the Chemical Engineering Section of the Dominion Laboratory, is technically feasible

POLITICAL SCIENCE AS A UNIVERSITY SUBJECT

A REPORT on "The University Teaching of Social Sciences Political Science"* has been prepared by Prof William A Robson on behalf of the International Political Science Association and published by the United Nations Educational, Scientific and Cultural Organization. Political science, writes Prof. Robson, "is, no doubt, the master science which can do most to assuage the maladies and struggles and conflicts of man in society", this is so, he argues, because "political science is concerned with the study of power in society"—a "fundamental concept" which "integrates all the various branches of the subject" Having regard, then, to the troubles of the world in which we live and the "burning practical importance" of political science, it might be expected that a large measure of attention would be paid both to teaching and to research in the subject, but the interesting and painstaking survey of developments in this field which Prof Robson has carried out shows that this is far from the fact His assumptions about the nature of political science being what they are, this leaves him with an interesting problem to solve

What Prof Robson has to say is illuminating, but somewhat pessimistic Political science exists as an under-developed territory, or backward area, within the universities of the Western world because it has never cut itself adrift from other subjects, such as law, economics and philosophy It is treated as a somewhat unwanted step-child, whereas, he asserts, it should be accepted as "a separate and clearly distinguished discipline" to which the same status should be accorded as any other of the basic subjects that form part of the university curriculum of a liberal education It is simply because those who have been responsible for making university and public policy have failed to recognize the importance of teaching and research in political science, Prof

---

* The University Teaching of Social Sciences Political Science By W A Robson Pp 252 (Paris Unesco, London H M S O, 1954) 1 50 dollars, 8s 6d, 400 French francs

Robson suggests, that the present somewhat lamentable state of affairs has arisen

On the other hand, it may be asked what have political scientists done to establish themselves in the influential position which Prof. Robson has marked out for them Is theirs, in fact, a 'master science' ? Here Prof Robson injects into the discussion some very wise remarks, which place the problem of the under-development of political science in a somewhat different setting It is evident to him that, in the light of our present knowledge, it is beyond the power of political science "to formulate general laws which associate in a precise manner particular causes with specified effects". The political scientist is, indeed, "dealing with a realm of thought and action about which men and women hold the most profound differences of opinion and belief" His methods are imprecise, and his work is apt to be influenced too directly by the winds of passion If this is accepted as the truth, where, it must be asked, do political scientists stand in relation to the other social and natural sciences ?

The bold claim that political science can exist as a 'master science' must indeed be relinquished in favour of something more humble. The solving of such problems as the 'cold war', the international control of atomic energy, race relations in Africa, the stimulation of "genuine citizen participation in government", and the protection of the world against "stiff-necked bureaucracies incompatible with democracy", which Prof Robson regards as the concern of the political scientist, is a task that will require the collaboration of all social scientists—supposing that they do not prove to be too much for the wit of man altogether. If political science is to flourish it must, in present circumstances, accept more help from the other social sciences than it contributes to them

We thus find ourselves in the position of seeking the foundations of a political science that can be taught as part of a liberal education. It may be suggested that it is because this has not been done with sufficient intellectual courage that the subject has failed to expand with the rapidity that the necessities of our times would appear to demand The solving of the political problems that are so essentially bound up with the acquisition and exercise of power within any society can only be achieved on an empirical basis, it is only in this way that we shall be able to lay the foundations of a subject of study which can be called truly scientific

In Great Britain we are in an especially favourable position to attempt this, because our tradition in political science has always been empirical or practical as well as philosophical or theoretical. We have never taken a sentimental or idealized view of the personalities or behaviour of our rulers As William Pitt remarked at the end of the eighteenth century, "unlimited power is apt to corrupt the minds of those who possess it", and we have acted accordingly It was in Prof Robson's own London School of Economics that Graham Wallas made such strenuous efforts to apply practical wisdom of this kind to the conditions of his own day, and it is for the contemporary political scientist, in collaboration with sociologists, anthropologists and psychologists, to work out a theory dealing with the use of political power which can be applied both to problems of government and administration, on one hand, and to those of the individual politician, administrator and citizen on the other T. S SIMEY

EFFECTS OF RADIATION AND OTHER DELETERIOUS AGENTS ON EMBRYONIC DEVELOPMENT

THE Biology Division of the United States Atomic Energy Commission sponsored a symposium on the effects of radiation and other deleterious agents on embryonic development, which was held on April 20, 1953, at the Oak Ridge National Laboratory, Tennessee The proceedings have been published as a supplement to the *Journal of Cellular and Comparative Physiology* (43, Supp 1, May 1954 Pp 337+6 plates, from the Wistar Institute of Anatomy and Biology, Philadelphia, n p). This symposium volume contains eleven full-length papers and some short but valuable summarizing remarks by Dr Paul Weiss. Each of the papers is followed by a discussion by the author and members of an obviously interested and critical audience

Four of the papers deal with the effects of ionizing radiations on developing embryos of the rat, an amphibian and the mouse, and one may perhaps add to this group a study on the outcome of pregnancy in women exposed to the atomic bomb blast in Nagasaki Experimental papers in this group have been mainly concerned to plot out the different types of radiation damage which follow exposure to irradiation at different times of embryonic development. The facts which are revealed are interesting and probably of considerable technological importance in a world in which ionizing radiation seems likely to become one of the normal hazards not only of war but also of peaceful industry. The interpretation which should be put on them still remains rather obscure Much of the discussion is in terms of critical periods, but, as Weiss points out, one is not justified in assuming that the crucial activities which bring about the final visible effects are produced at the actual time at which the irradiation is given, a situation which makes the identification of the critical periods by no means easy Moreover, the evidence suggests that radiation may produce many different types of damage, not only on the chromosomes but also on the cytoplasm

One might hope, perhaps, to have rather more understanding of the kind of damage produced by certain chemical substances such as the nitrogen mustards, the vitamins, cortisone, etc There are five papers dealing with such topics Again, the reader is confronted with a large amount of actual information, the explanation of which remains for the most part still to seek. Perhaps the most interesting of this group of papers is a further report by Landauer of the recent progress of his massive and thorough study of the production of phenocopies by chemical means in chick embryos In general, however, one gets the impression that our understanding of embryonic development would be better advanced by studies which employ agents the activities of which are more precisely understood than those of irradiation or toxic substances such as the mustards (for example, specific enzyme poisons or metabolic analogues), while for the interpretation of the embryonic effects of these 'blunderbuss' deleterious agents one will probably have to wait until studies on simpler systems have revealed more precisely the nature of the effects which they produce

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications

Chromosomes of Monkeys and Men

CHROMOSOME numbers have been recorded in very few species of primates All observations have been on the male, the heterozygous sex The following are the more serious references

OLD WORLD PRIMATES			
Homo sapiens	European and Negro	48	Painter[1], Koller[2], La Cour[3], Hsu[4]
	Japanese	47	Oguma[5]
Pan calvus	Chimpanzee	c 48	Yeager *et al* [6]
Macacus mulatta	Rhesus macaque	48	Painter[7]
NEW WORLD MONKEY			
Cebus sp	Capuchin monkey	54	Painter[7]

Recent developments of technique, however, enable us to count the numbers and describe the forms of mammalian chromosomes with the same ease and accuracy as has long been possible for grasshoppers and newts We have therefore examined all the species of primates available to us The following are our counts (Figs 1–4)

Homo sapiens	
European, bone marrow (Fig 1) Indian testis	48
Papio papio, Guinea baboon, testis (Fig 2) *Macacus nemestrina*, pigtailed monkey, testis (Fig 3) *Macacus mulatta*, Rhesus macaque, testis (Fig 4)	42

The chromosomes of man and monkeys are generally not unlike In the spermatogonia illustrated they are, of course, more contracted than in the pre-myelocytes of the bone marrow With regard to the individual chromosomes we agree with Koller (who has studied meiosis), and with La Cour and Hsu, that in man X is a medium-sized chromosome and Y one of the smallest, although not individually recognizable at mitosis

The three species of monkey are alike in two respects in which they differ from man First, they lack the pair with median centromeres which is the largest pair in the human complement. Secondly, they have a Y chromosome which is much smaller than the human Y It is also much smaller than any other chromosome in their own complements and is therefore at once and always recognizable at mitosis (Figs. 2–4)

Since almost the whole of the Y in man can be accounted a pairing segment exchangeable between X and Y, all three monkeys must have a much shorter length of X–Y exchangeable genes than man The difference between man and monkey should show at meiosis, of which an account will be published later The similarity between the monkeys, on the other hand, should be seen in their capacity for hybridization. A cross has in fact been made between *Papio sphinx* ♀ and *Macacus mulatta* ♂, and offspring have been raised in captivity

These observations indicate that, apart from Painter's study of man, the earlier accounts based on sectioned material are not to be relied upon. They especially lead us to reject Oguma's claim of an unpaired X chromosome in the human male The Y chromosome is obvious and characteristic in all our four species as it has been in all other mammals studied Its absence, which would require an innovation in the centromere of the unpaired X, has never been established in any vertebrate

Finally, our observations show, what has not so far been clear, that chromosome form and number are unstable in the primates Both sex chromosomes and autosomes can be used to test relationships of descent. With this regard we should like to repeat the opinion[8] that the chromosomes of the great apes should be studied before these species die out altogether In order to facilitate this we must mention that our technique is a slight modification of that described by Sachs[9,10] Anyone who is able to obtain fresh monkey testis material should fix it in fresh 1 3 acetic alcohol and keep it, after twelve hours, at 0° C. Feulgen squash preparations should, however, be made as soon as possible (after twelve hours) Fixations may be sent by airmail to Dr A Haque, Botany Department, University of Dacca, East Pakistan

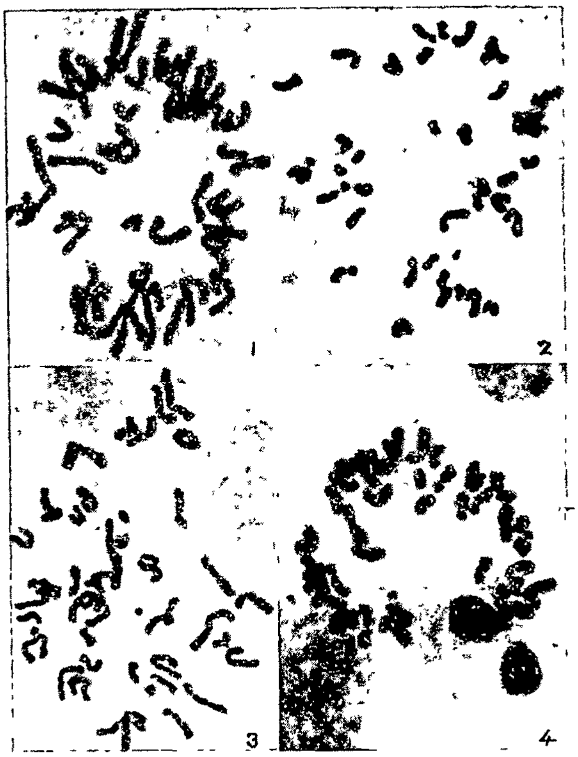


Fig 1 Bone marrow, pre-myelocyte, man (× c 2,140)

Figs 2–4 Spermatogonium of monkeys (Fig 2, × 1,844, Figs 3 and 4, × c 2,140) All acetic alcohol Feulgen squashes Note the small Y chromosome is at 5 o'clock in Fig 2, central in Fig 3, and at 7 o'clock in Fig 4

We wish to thank the following for material and for their very kind help Prof S Zuckerman, Dr A. P. D. Thomson and Dr P Eckstein, of the Birmingham School of Medicine, for the baboon and macaque, Prof E G. T Liddell, Dr. P Glees and Dr. J Cole, of the Oxford Department of Physiology, for the pigtailed monkey, and Dr M. A Nomani of King Edward Hospital, Benares, India, for the human testis fixation

C D DARLINGTON
ASHRAFUL HAQUE

Botany Department,
University of Oxford Dec. 1

[1] Painter, T S, *Amer Nat*, **59**, 664 (1925)
[2] Koller, P C, *Proc Roy Soc Edin*, **57**, 194 (1937)
[3] La Cour, L F, *Proc Roy Soc Edin*, **62**, 10 (1944)
[4] Hsu, T C, *J Hered*, **63**, 4 (1952)
[5] Oguma, K, *J Morph*, **61** (1937)
[6] Yeager, C H, Painter, T S, and Yerkes, R M, *Science*, **91**, 235 (1940)
[7] Painter, T S, *J Exp Zool*, **39**, 3 (1924)
[8] Darlington, C D, *Nature*, **171**, 191 (1953)
[9] Sachs, L, *Heredity*, **6**, 357 (1952)
[10] Sachs, L, *Stain Tech*, **28**, 169 (1953)

Delayed Toxicity of Radiostrontium in Monkeys

IN a long-term experiment on the effects of low doses of radiostrontium, six monkeys have died following single injections of pure 'carrier-free' strontium-90 of less than 0 2 mc /kgm body-weight The hæmatological findings, and the comparison of survival-times with those obtained in animals which received higher doses[1], are noteworthy

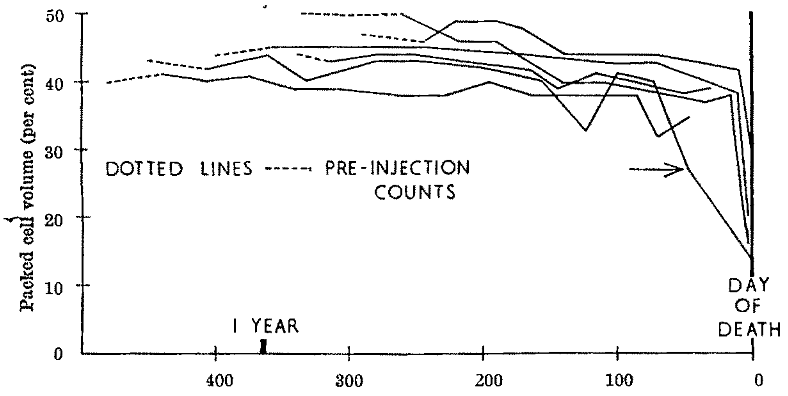


Fig 1

The blood picture in the six animals did not seriously deteriorate following the injections until a sharp terminal fall shortly before death, as shown in the graph of packed cell volume (Fig 1) In four of the animals, the hæmatological findings were within normal limits until two or three weeks before death, and in only one case was there any significant gradual decrease in red blood cell count and packed cell volume before the terminal drop Only in one animal (marked → on Fig 1) was a severe drop in white blood cells observed , the count fell from 13,000/mm ^{3} 46 days before death, to 1,200/mm ^{3} at death. The animals appeared in normal health until about a week before death

In the three animals which were examined histologically, the most severe lesions were seen, as expected, in bone marrow, reproductive organs, and reticulo-endothelial system. Damage in the latter varied widely in the different animals In one animal the spleen exhibited extreme atrophy, whereas in another the germinal centres were large and prominent with numerous mitotic figures present

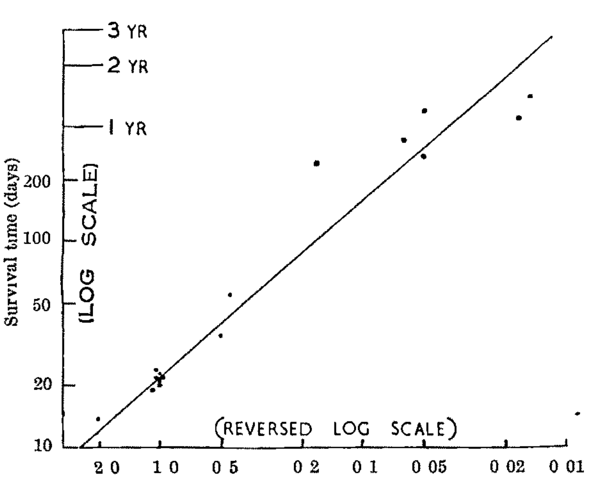


Fig 2

It is notable that the times of survival for the six monkeys fit the straight-line extrapolation of the graph of survival times for the thirteen 'high-dose' monkeys (Fig 2)

All the monkeys were kept on a good mixed diet of medium calcium content, and the radiostrontium content of their fæces and urine was assayed The logarithm of daily excretion was plotted against the logarithm of time T (days) after injection, and from the straight line for the whole period the relationship

$$E \text{ per cent} = 10\,T^{-1\,0}$$

was deduced for the daily excretion, E per cent, of the injection dose. The carcass at death contained an average of 30 per cent of the injection dose

The investigation is continuing, and we intend to report elsewhere on the details of histopathology, hæmatology and radioactivity assays. Observations to date on the twelve surviving monkeys do not conflict with these preliminary findings

Acknowledgments are due to Mr A H Booth and the College authorities, and to the Medical Research Council

G M EDINGTON*
J M JUDD†
A H WARD
University College of the Gold Coast,
Achimota Oct 18

---

* Of the Medical Research Institute, Korle Bu, Gold Coast

† Now with Department of Tsetse Control, Gold Coast

[1] The first eight of the thirteen 'high-dose' deaths were reported in *Nature*, 172, 122 (1953)

Action of Ionizing Radiations on Catalase in Presence of Cysteine, Cystine and Glutathione

FORSSBERG[1] reported that cysteine and glutathione did not protect catalase against inactivation by X-rays, but on the contrary increased the radiation effect on the enzyme Most organic substances act as protectors when added as a second solute to the solution of the primary solute Since cysteine and glutathione have been used in protection experiments *in vivo*[2,3] and *in vitro*[4,5] it was decided to re-investigate the inactivation of catalase by irradiation, in view of the apparently exceptional nature of the effect of these substances

Two types of radiation have been used γ-rays from cobalt-60, and high-energy electrons from a linear electron accelerator Beef liver catalase was irradiated alone and in the presence of cysteine, cystine and glutathione (—SH), and the resultant effects on the enzymatic activity, electrophoretic and chromatographic behaviour and on the ultra-violet absorption were examined

Doses up to 93 × 10^6 ergs/gm were used, and the catalase concentration varied from 2 25 × 10^{-4} gm / ml. to 4 45 × 10^{-3} gm /ml Irradiation was carried out in air, oxygen and nitrogen at pH 7 4 (*a*) Catalase activity was measured by the method of Bonnichsen, Chance and Theorell[6]. All three substances depressed catalase activity *per se*, but protected the enzyme against radiation. At low radiation doses failure to take account of this depressing effect can lead to the apparent result of an increase of the radiation effect.

(*b*) Paper electrophoresis of unirradiated catalase showed a single spot, whereas irradiated catalase gave a comet-shaped streak. When irradiation took place in the presence of cysteine or glutathione, the subsequent electrophoretic pattern was the same as that of the unirradiated solution; that is, one spot appeared in the same position as unirradiated catalase. Protection occurred with cystine too, although to a lesser degree due to its low solubility.

(*c*) The chromatographic behaviour of catalase changed markedly after irradiation. This change did not occur when cysteine or glutathione was present during irradiation, and was not so pronounced when cystine was used.

(*d*) Catalase shows two maxima in the ultra-violet, at 275 mμ and 405 mμ. In the present instance, D_{405}/D_{275} = 0·685. After irradiation the absorption increased at 275 mμ and decreased at 405 mμ, so that D_{405}/D_{275} = 0·226. When cysteine or glutathione was present during irradiation, the absorption did not change.

Thus catalase is protected against γ-rays and high-energy electrons by cysteine, cystine and glutathione. It is noteworthy that the oxidized form of cysteine, namely, cystine, is nevertheless able to compete for the radicals produced by radiation.

This work will be reported in detail elsewhere.

W. M. DALE
C. RUSSELL

Department of Biochemistry,
Christie Hospital and Holt Radium Institute,
Manchester 20. Sept. 17

---

[1] Forssberg, A., *Nature*, **159**, 308 (1947).

[2] Patt, H. M., Smith, D. E., Tyree, E. B., and Straube, R. L., *Proc. Soc. Exp. Biol. Med.*, **73**, 18 (1950).

[3] Chapman, W. H., and Cronkite, E. P., *Proc. Soc. Exp. Biol. Med.*, **75**, 318 (1950).

[4] Kepp, R. K., and Michel, K. F., *Strahlentherapie*, **92**, 416 (1953).

[5] Holmes, B., *Nature*, **165**, 266 (1950).

[6] Bonnichsen, R. K., Chance, B., and Theorell, H., *Acta Chem. Scand.*, **1**, 685 (1947).

Radiation Dosimetry of Rubidium-86

INTEREST has recently arisen in the possibility of using rubidium-86 as a tracer for potassium in biological studies where the short half-life of potassium-42 presents difficulties[1]. In order that an assessment may be made of the radiation dosage arising from the use of this isotope, the γ-ray output and mean β-ray energy have been measured. Rubidium-86 decays with the emission of a 1·80 MeV. β-ray or by a 0·72 MeV. β-ray followed by a 1·08 MeV. γ-ray[2]. The results reported here indicate that the γ-ray occurs in about 8·4 per cent of disintegrations.

The material produced by neutron irradiation of the purest rubidium chloride at present available contains considerable activity from cæsium-134. A sample of the irradiated material was therefore purified by seven recrystallizations of the acid tartrate, after which only about 0·05 per cent of the disintegrations were due to cæsium-134 (as judged by the subsequent increase in the ratio of γ- to β-ray activity over a period of three months). The disintegration-rate of an aliquot of this material was determined by 4π-ray counting, a method which has been found satisfactory for emitters of relatively high-energy β-rays[3].

The γ-ray dose-rate was measured by comparison against a radium standard, using a graphite ionization chamber, and assuming that 1 mgm. of radium screened by 0·5 mm. of platinum gives 8·3 r./hr. at 1 cm. The emission of β-ray energy was measured by the method of Gray[4], in which the ionization produced in a chamber lined with agar containing a known concentration of the active material is compared with the ionization produced by a standard radium source at known distance. The ionization measurement was related to energy absorption on the assumption that 32·5 eV. is required for the formation of an ion-pair in air. It was found that the average energy emitted as β-rays per disintegration of rubidium-86 is 0·66 MeV., and that the γ-ray dose-rate at 1 cm. from 1 mc. is 0·525 r./hr. An appreciable fraction of the γ-ray effect is due to bremsstrahlung. Since these radiations fall largely in a region where the sensitivity of the chamber changes rapidly with quantum energy, it is not possible to calculate the contribution, but its magnitude can be inferred from the figure 0·025 r./hr. at 1 cm. obtained from 1 mc. of phosphorus-32 under similar conditions.

In view of the closeness of the maximum energies of the β-rays of these two isotopes, it is reasonable to assume that the bremsstrahlung effect is proportional to the square of the maximum energy, when, allowing for the presence of the low-energy branch, the bremsstrahlung of rubidium-86 would give 0·027 r./hr./mc. at 1 cm. The 1·08 MeV. γ-ray therefore gives 0·50 r./hr./per mc. at 1 cm., a figure which leads to the conclusion that the γ-ray is emitted in only 8·4 per cent of disintegrations. Accepting this figure for the branching ratio, and allowing for the forbidden shape of the β-ray spectrum[5], the calculated value of the mean β-ray energy is 0·70 MeV. The discrepancy between this figure and the experimental results is scarcely greater than the uncertainty of the value assumed for the energy of formation of an ion-pair.

A regression line calculated from seventeen observations over a period of 79 days gave a figure of 18·74 ± 0·026 days for the radioactive half-life of a sample of rubidium-86. This reduces to 18·66 days when allowance is made for the 0·05 per cent cæsium-134 initially present.

We are indebted to the Medical Research Council for the loan of the equipment used in the ionization measurements.

E. W. EMERY

Department of Medicine,
University, Manchester

J. E. S. BRADLEY

Postgraduate Medical School,
London, W.12

N. VEALL

Physics Department,
Guy's Hospital Medical School,
London, S.E.1
Nov. 1

---

[1] Love, W. D., Romney, R. B., and Burch, G. E., *Circulation Res.*, **2**, 112 (1954).

[2] Hollander, J. M., Pearlman, I., and Seaborg, G. T., *Rev. Mod. Phys.*, **25**, 469 (1953).

[3] Perry, W. E., "Standardisation of Radioactive Isotopes" (National Physical Laboratory, 1953).

[4] Gray, L. H., *Brit. J. Radiol.*, **22**, 667 (1949).

[5] Wu, C. S., *Rev. Mod. Phys.*, **22**, 386 (1950).

Removal of Background in β-Sensitive Nuclear Emulsions

We have tried to reproduce the procedure recommended by H Faraggi[1] and G Albouy[2] for removing the background on Ilford *G*5 plates before experimental exposure The treatment consists in suspending the plates for a certain time in water vapour of a given temperature. After we had made a number of unsuccessful attempts following the methods of other investigators[3], it occurred to us that the small chlorine content of Paris water might be responsible for the difference in the results We tried water containing 12 mgm chlorine per litre for the production of the water vapour, and found that we could remove the background at 60° C in five hours (instead of twenty hours required by the French investigators) without affecting the sensitivity of the plates to subsequent β-rays if the plates were dried after the treatment. α-Tracks withstood this treatment These results seem to throw some light on the process involved.

Details and further experiments under varying conditions will be published in the *Proceedings of the Vienna Academy of Sciences* (*Wien Ber*)

T Matitsch
Ch Matiasek
B Karlik

Institut fur Radiumforschung der
Akademie der Wissenschaften,
Vienna.
Sept 14

[1] Faraggi, H , *Rev Sci Instr* , 220, 532 (1951)

[2] Albouy, G , *C R Acad Sci* , *Paris*, 230, 1351 (1950) Albouy, G , and Teillac, J , *C R Acad Sci* , *Paris*, 232, 326 (1951)

[3] Marguin, G , and Maitrot, M , *J Phys et le Radium*, 15, 123 (1954) Rieder, G , Max Planck Institut fur Metallforschung, and other private communications

---

Interaction of Two Constituents in Ferromagnetic Materials showing Reverse Thermo-remanent Magnetism

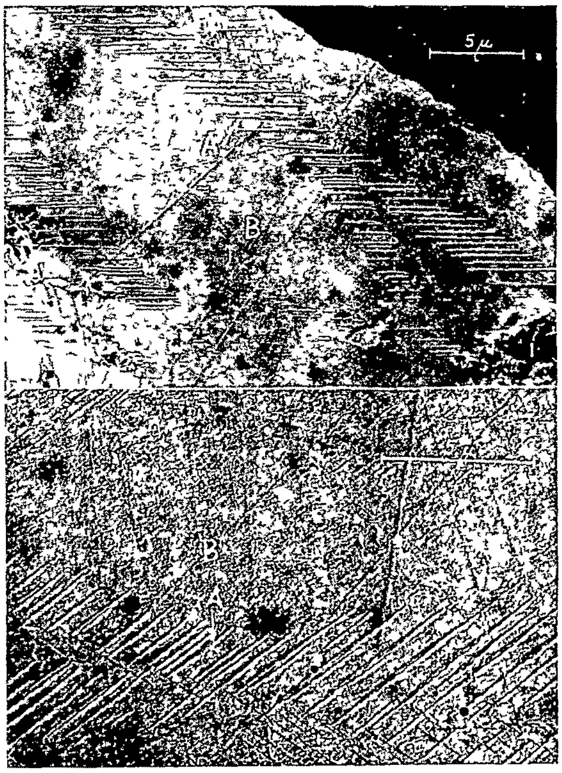
In three earlier communications[1], we described the magnetic, chemical and crystallographic properties of the ferromagnetic minerals causing self-reversal of thermo-remanent magnetization of igneous rocks The results of studies of these properties showed that most grains of ferromagnetic minerals in the Haruna dacitic rocks consist of two different ferromagnetic constituents , one called *A* is titanium-poor titanomagnetite having a crystal structure of inverse spinel type and Curie point around 500° C. , another called *B* is a solid solution of ilmenite and hæmatite (hæmo-ilmenite) having rhombohedral crystal structure and Curie point of about 230° C.

All the magnetic experiments showed that the reversed thermo-remanent magnetism of these minerals and their mother rock is due to the effect of close interaction of these two different ferromagnetic constituents during the process of their cooling in a magnetic field This is in full agreement with Néel's[2] two-constituent theory of reverse thermo-remanent magnetism But it was not clear how these constituents interact with each other in actual mineral grains

It was found, on the other hand, that a simple mixture of these two constituents does not show reversed thermo-remanent magnetism even when the mixture is tightly compressed Therefore, it may be presumed that the relationship of these constituents to each other is a form of intergrowth of one into another, thus resulting in a very close interaction between them.

Figs 1 and 2 show electron-microscope photographs of etched surfaces of ferromagnetic minerals in the Haruna rock. The polished surfaces of the minerals were etched by hydrochloric acid for 15 min , parts of constituent *A* (being approximately magnetite) can easily be etched, but parts of constituent *B* are scarcely affected The original photographs have magnifications of 4,900 (for Fig 1) and 8,000 (for Fig 2) It is clearly shown in these figures that constituent *A* intergrows in echelon into constituent *B* The width of strips of constituent *A* is approximately 0 2 μ. The length of the strips ranges apparently from 1 μ to 5 μ in the photographs , but it seems likely that these strips are more or less linked one to another along specified directions forming fairly long strips of narrow width.

Judging from the above-mentioned scale of strips of constituent *A*, we may presume that each strip consists of a single domain or several domains In other words, the magnetization of these strips may be of the same order as the spontaneous magnetization of constituent *A* Then the magnetic field caused by the strong magnetization of strips of constituent *A* in the neighbouring strips (of mean width 0 5 μ) of constituent *B* will be, on the average, opposite to the direction of magnetization of the strips of *A*, which must be parallel to that of the external magnetic force The detailed calculations cannot be reproduced here, but it can be shown that the magnetic interaction between strips of constituents *A* and *B* mentioned above can result in reverse thermo-remanent magnetization



Intergrowth of constituent *A* in echelon into constituent *B* in a Haruna ferromagnetic mineral

Table 1 CRYSTAL STRUCTURE AND CURIE POINT OF CONSTITUENTS *A* AND *B* IN DACITES AT HARUNA, ASIO AND TOWADA, JAPAN

Locality	Constituent	Crystal structure	Lattice parameter	Curie point
Haruna	*A*	Cubic	A_c =8 403±0 002 A	460° C
	B	Rhombohedral	A_{rh}=5 480±0 002 A α_{rh} =55° 08′±01′	230° C
Asio	*A*	Cubic	A_c =8 397±0 004 A	460° C
	B	Rhombohedral	A_{rh}=5 483±0 004 A α_{rh} =55° 01′±03′	230° C
Towada	*A*	Cubic	A_c =8 412±0 003 A	390° C
	B	Rhombohedral	A_{rh}=5 491±0 001 A α_{rh} =54° 59′±01′	100° C

Thus, it seems that the mechanism of producing the reverse thermo-remanent magnetism in the Haruna ferromagnetic minerals is established It is also true, however, that the presence of these two different constituents, *A* and *B*, in rocks does not always result in the self-reversal of thermo-remanent magnetism As shown in Table 1, ferromagnetic minerals of dacites at Haruna, Asio and Towada in Japan are composed of similar constituents, their magnetic properties closely resembling each other The total thermo-remanent magnetism of the Haruna rocks is reverse, but the total thermo-remanent magnetism of the majority of the Asio rocks is normal at the atmospheric temperature, though there is a distinct tendency towards reversed magnetization of constituent *B* in the latter In the Towada rocks, the total thermo-remanent magnetization is perfectly normal, the direction of constituent *B* being parallel to that of constituent *A* The magnetic interaction between *A* and *B* is strongest in the Haruna rocks and the weakest in the Towada rocks, where it is practically negligible Thus it may be concluded that the self-reversal of thermo-remanent magnetization owing to the two-constituent mechanism can take place in rocks only under the particular condition that ferromagnetic minerals consist of the *A*- and *B*-constituents, and further that they are closely coupled as regards scale of domain, as illustrated, for example, in Figs 1 and 2

Thanks are due to Prof J Bartels and other members of the Geophysikalisches Institut, Gottingen, for their help in preparing this communication and for discussions

T NAGATA
S UYEDA

Geophysical Institute,
Tokyo University
Oct 13

[1] Nagata, T , *Nature*, 169, 704 (1951) , 172, 850 (1953) Nagata, T , *et al* , *Nature*, 172, 630 (1953)

[2] Néel, L , *Ann Geophys* , 7, 90 (1951)

An Attempt to observe Whistling Atmospherics near the Magnetic Equator

THE 'whistling atmospheric', or 'whistler', is the most common of the several types of quasi-musical atmospheric that are observed in the audio-frequency band of the radio spectrum It takes the form of a whistling tone that falls steadily in pitch, appearing at about 10 kc /s and falling to about 1 kc /s in the space of 1–4 sec A recently published study of these atmospherics[1], based on observations made at the Cavendish Laboratory, Cambridge, during 1950–51, gives support to the theory of Barkhausen[2] a Eckersley[3], which supposes them to be produced dispersion in the ionosphere of the impulsive atn spheric 'clicks' radiated by lightning strokes T whistlers are thought to travel through the ionosphe in the extraordinary (right-hand circularly polarize magneto-ionic mode of propagation, in which mo at frequencies below the gyro-frequency, the wa are able to penetrate the lower ionosphere withc suffering total reflexion For the details of this thec reference should be made to the sources cited , h it is sufficient to state that the characteristics of t extraordinary mode are found to be strongly fluenced by the earth's magnetic field, and t resulting anisotropy is such that the ray paths the whistlers through the ionosphere must follow t lines of force It is evidently a consequence of t theory that the occurrence and properties of t whistlers should depend on the magnetic latitude the point of observation, and in particular that th should not occur near the magnetic equator, whe the lines of force are horizontal and the waves, the fore, unable to travel up through the lower ionosphe to the less absorbing regions above

In order to test this prediction, one of us (J R has carried out a series of observations in the aud frequency band at Achimota, Gold Coast (lat 6° long 0° 12′ W), which is about 10° north of t geomagnetic equator The atmospherics were receiv on the equipment that was previously used in t experiments at Cambridge The work extended ov about three years, from December 1951 to Mar 1954, and consisted in all of seventy listening perio averaging about 15 min. each Listening was do at varying times of day and night, but especially the late afternoon and evening, which had prov to be favourable times of day for whistlers in t Cambridge records Nevertheless, at no time duri the whole series were any whistlers detected, thou the usual varieties of impulsive atmospheric[4] we plentiful As frequent checks were made of t gain-level and correct functioning of the receiv it is unlikely that any whistlers could ha occurred during the listening periods and escap notice

At middle latitudes whistlers are quite commo and their rate of occurrence is largely independe of time of year[4] In the Cambridge observations t mean rate for all hours was 1 3 per min , while t figure for 1730 G M T , when activity tended to highest, was 3 1 per min During November 195 April 1954, some records of audio-frequency atm spherics at Chelmsford, England, were taken intervals by Isted, in connexion with some studies very high-frequency scatter phenomena[5], and wh no systematic counts of whistlers were made, it w noted that they were maintaining their norm activity (private communication) Thus it is know that during much of the period covered by o observations whistlers were in evidence at midd latitudes, and probable that this was the case duri the remainder It therefore appears that the failu to observe them at Achimota was due to a genui effect of magnetic latitude, in agreement with t theoretical predictions

Acknowledgment is made to Prof H E Huntle and the staff of the Physics Department of t University College of the Gold Coast for faciliti and assistance in connexion with this work We a most grateful to Mr G A. Isted, of the Marco Wireless Telegraph Company, Ltd , for allowing to make use of his unpublished results One of us (L R O S) is indebted to the Chief Scientist, Ministry of Supply, for permission to contribute to this communication

J R Koster
Physics Department,
University College of the Gold Coast,
Achimota, Gold Coast

L. R O Storey
Radar Research Establishment,
(Ministry of Supply),
Malvern, Worcs.

[1] Storey, L R O, *Phil Trans Roy Soc*, **246**, 113 (1953)
[2] Barkhausen, H, *Proc Inst Rad Eng*, *N Y*, **18**, 1115 (1930)
[3] Eckersley T L, *Nature*, **135**, 104 (1935)
[4] Burton, E T, and Boardman, E M, *Proc Inst Rad Eng*, *N Y*, **21**, 1476 (1933)
[5] Isted, G A, *Marconi Rev*, **42**, 37 (1954)

Change of Elastic Constants in a Superconductor

It is known[1] that there must be a small difference between the elastic constants of a superconductor in the superconducting and the normal states The difference expected is of the order of 1 part in 10^6, but no actual measurement has so far been reported We have now used a statical method to measure the change in the modulus of rigidity of a chemically pure polycrystalline tin wire when superconductivity is destroyed by a longitudinal magnetic field

The specimen was placed vertically in liquid helium, and fixed at the lower end The upper end was connected by a rigid rod to a phosphor bronze wire at room temperature A twist applied to the top of the bronze wire then distributed itself between the two wires according to their torsional constants This equilibrium distribution of strain changed on destruction of superconductivity, and the change was observed by means of an optical lever, as described by Jones[2]. Too much torsion of the tin caused excessive creep, so that the deflexion changes actually measured were less than 5×10^{-7} radians

The results of several runs are plotted in Fig 1 in the form $(G_n - G_s)/G_n$, where G_n and G_s are the rigidities in the normal and superconducting states respectively.

Absolute calibrations are only available for some of the runs Results for the uncalibrated runs have been normalized to fit the calibrated runs at 2° K, and they are thus of help in establishing the dependence of the effect on temperature The full curve represents the function $A\{1 - (T/T_c)^4\}$, where T_c is the transition temperature, and the constant A has been chosen for agreement with the observations at 2° K It can be deduced from work on the change of critical field of tin with stress[3] that the difference in volume between the superconducting and normal states may be expected to be dependent on temperature in this way. This is also in agreement with the work of Lasarew and Sudovstov[4] It can easily be shown that, in any event for a lattice with central forces, the difference in the shear moduli of the two states will depend on temperature in the same way as the volume difference

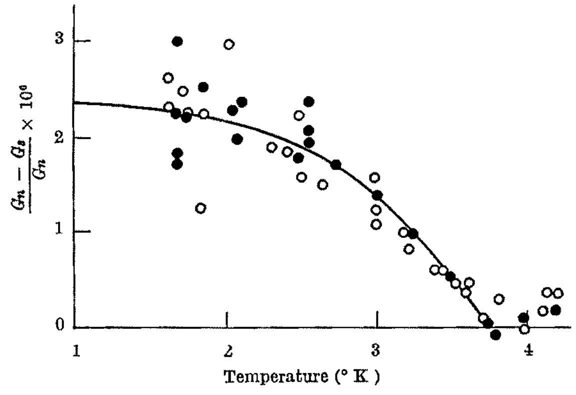


Fig 1 Temperature variation of $(G_n - G_s)/G_n$ for tin ●, Runs with direct calibration, ○, uncalibrated runs normalized to fit at 2° K The full curve represents the function $A\{1 - (T/T_c)^4\}$ with A chosen to fit the results at 2° K

I am grateful to Prof P Grassmann, in whose Institute this work was done, for his interest and encouragement

J L Olsen
Institut fur Kalorische Apparate und Kaltetechnik,
Eidgenossische Technische Hochschule,
Zurich
Nov 8

[1] Shoenberg, D, "Superconductivity", 74 (Cambridge, 1952)
[2] Jones, R V, *Proc Phys Soc*, B, **64**, 469 (1951)
[3] Grenier, C, Spondlin, R, and Squire, C, *Physica*, **19**, 833 (1953)
[4] Lasarew, B G, and Sudovstov, A I, *Doklady Akad Nauk S S S R*, **69**, 345 (1949)

A Phase Diagram for 1 per cent Carbon–Iron Alloys containing up to 16 per cent Nickel

During the course of an investigation into the austenite stabilization phenomena of iron–nickel alloys containing 1 per cent carbon, it became necessary to obtain some knowledge of the limiting solubility of the carbide in the austenite There appeared to be no specific information available concerning the phase relationships of such alloys and, due to the promotion of graphitization by high nickel contents[1], a great deal of uncertainty attends the nature of the iron–carbon–nickel ternary system

Casts weighing 18 lb were made in a high-frequency furnace, the ingots, the analyses of which are given in Table 1, were forged to $\frac{5}{16}$-in diameter rods which were normalized from 1,050° C Specimens were machined, nickel-plated and tempered for 24 hr at 600° C before testing The progress of transformation was followed dilatometrically, using a dilatometer previously described[2], and temperatures measured by means of platinum/platinum–rhodium thermocouples peened centrally into the specimens Readings were taken at 5 deg C intervals with a heating-rate of 1 deg C per min

The results, presented in Fig 1, agree very well with the 1 per cent carbon section which may be

Table 1 Principal Alloying Elements of the Nickel Steels examined

No	% C	% Ni	% Si	% Mn
1	1 02	0 03	0 23	0 32
2	1 04	0 66	0 19	0 36
3	0 98	1 03	0 13	0 39
4	1 02	2 01	0 15	0 31
5	1 02	3 06	0 21	0 34
6	1 00	4 09	0 13	0 32
7	1 00	5 06	0 26	0 25
8	0 93	7 10	0 30	0 19
9	1 04	9 9	0 22	0 26
10	0 99	15 8	0 47	0 42

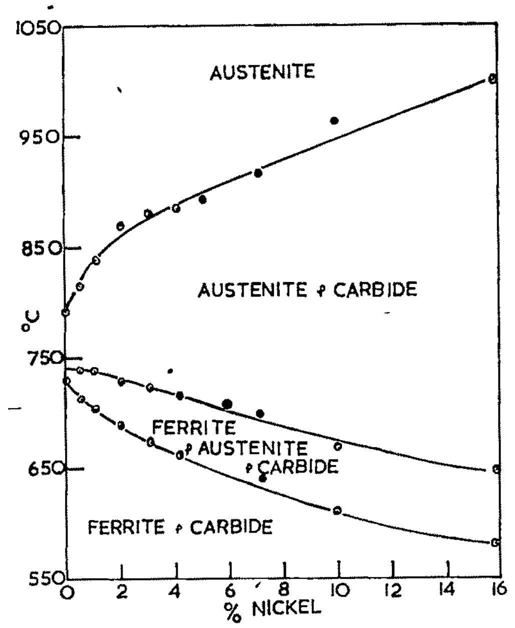


Fig 1 Phase diagram for iron–carbon–nickel alloys containing 1 per cent carbon and 0 3 per cent manganese, heating-rate 1 deg C/min

derived from a ternary diagram based on the assumption of carbide stability Thus Fig 1 does not take into account the presence of graphite, which may be found in the higher nickel alloys The effect of graphitization has been investigated[3] in an attempt to explain an anomalous increase in retained austenite with increasing austenitizing temperatures for certain nickel steels This abnormality was not observed in similar steels produced by carburization[4], a fact which may possibly be explained by the absence of graphite As the latter steels were not prepared from the melt or subjected at any time to very high temperatures, the tendency to graphitize may not have been so pronounced

Graphite was observed in the alloys containing 5 per cent nickel and more, but was not appreciable except in the higher nickel alloys These alloys also gave increased retained austenite contents on quenching from temperatures above those at which all the carbides were in solution Estimates of the graphite content of the 15 8 per cent nickel alloy were made after quenching from various temperatures The results are presented in Table 2 and indicate rapidly increasing solubility of the graphite with increasing temperature of treatment

It is suggested that there is a graphite solubility line above, and roughly parallel to, the carbide line in alloys containing more than 5 per cent nickel

Pronounced depression of the austenite–ferrite transformation on cooling is a characteristic feature of these alloys, and the diagram presented is not generally applicable to transformations on cooling

Table 2 Analysis of Graphite retained on quenching Steel 10 from Different Temperatures

Spec No	Oil-quenched from	Microscopic appearance	% Graphite by chemical analysis
A 1	750° C	Uniformly dispersed fine nodules of graphite	0 46
A 2	920° C	As *A* 1 but smaller amount	0 18
A 3	1,020° C	As *A* 1 but very much smaller amount	0 04
A 4	1,100° C	As *A* 3	0 05

P Samuel
L G Finch
J R Rait

Hadfields, Ltd,
East Hecla Works,
Sheffield 9

Sept 13.

---

[1] Marsh, J S, "Alloys of Iron and Nickel" (McGraw-Hill, New York 1938)

[2] Ward, J O, Jepson, M D., and Rait, J R, *J Iron and Steel Inst* 170, 1 (1952)

[3] Sadovskii, V D, and Bogacheva, G N, *Doklady Akad Nauk SSSR*, 83 (2), 221 (1952)

[4] Otte, H M, and Ko, T, *J Iron and Steel Inst*, 173 (1953)

Tidal Forces and the Formation of Hurricanes

Recently, it has been suggested that tidal forces may play a part in the formation of hurricanes[1]. The idea that extra-terrestrial influences may serve in triggering atmospheric phenomena has also received attention from other points of view in recent articles[2,3] However, it is to be questioned whether the hurricane data presented in Prof. C H Smiley's communication offer much support for the tidal hypothesis

Table 1

Dates and total No of hurricanes forming in each 7-day period as given in ref 1		Total No of hurricanes per 7-day period for the period 1886–1951*		
		East of 70° W	West of 70° W	Total
Aug 24–31	28	25	8	33
Sept 1–7	27	27	13	40
Sept 8–14	40	31	17	48
Sept 15–22	28	17	17	34
Sept 23–30	17 5	10	15	25
Oct 1–7	27	18	21	39
Oct 8–14	26	16	23	39

* These data were assembled by Mr J A Colón, University of Chicago They cover a somewhat longer period than those cited by Smiley This accounts for the differences between columns 1 and 4

The number of hurricanes forming per week has been taken from Smiley's communication and is shown in the first column of Table 1 The increase in the number of hurricanes shortly before September 23 and the decrease after that date are cited as evidence that the frequency of formation is in phase with the magnitude of the tidal forces However, a somewhat different distribution is obtained if the hurricanes are split into two groups using the 70th meridian as a dividing line This tabulation, columns 2 and 3 of Table 1, shows that although formations east of 70° decrease substantially after the middle of September, those west of 70° increase even up to the middle of October Data from other areas can also be cited as evidence that no close relation exists between the frequency of tropical cyclones and the magnitude of the tidal forces. For example, data from the north Pacific[4] show that the maximum frequency of typhoon formation occurs about September 1 and shows an appreciable decrease by September 23

The large decrease from the number of hurricanes forming in the September 8–14 period to that for the September 23–30 period, which was shown to be statistically significant by Smiley, is quite interesting, however, since it shows up clearly in the divided data of Table 1 Presumably, this apparent singularity cannot be associated with the tidal forces, since the hurricane frequency increases again after September 30 whereas the tidal force is decreasing. However, it may perhaps be associated with the readjustment of the large-scale flow pattern of the atmosphere which must accompany the westward shift of the preferred area of hurricane formation during late September Charts of the frequency of hurricane formation prepared by Colón[5] show that during September and October the preferred areas of formation in the Atlantic and in the Caribbean – Gulf of Mexico are separated by a longitudinal strip centred on the 70th meridian in which relatively few storms form It might therefore be suggested that the low frequency of hurricane formation during the period September 23–30 is associated with a period when the atmospheric circulation in this region is in a transitional stage between the patterns which are favourable for eastern and western developments From this point of view the singularity, if indeed present, would be the result of significant changes in the atmospheric circulation over the subtropical Atlantic which occur at about the same time each year

CHARLES L JORDAN

Department of Meteorology,
University of Chicago,
Chicago 37, Illinois.

[1] Smiley, C H, *Nature*, 173, 397 (1954)

[2] Bowen, E G, *Aust J Phys*, 6, 490 (1953)

[3] Palmer, C E, *J Meteor*, 10, 1 (1953)

[4] Fifth Annual Report of the Typhoon Postanalysis Board, Anderson Air Force Base, Guam, Marianas Islands (mimeographed)

[5] Colón, J A, *Monthly Weather Rev*, 81 (1953)

MR. JORDAN's note suggests that the presence or absence of land has a good deal to do with the formation of hurricanes I am heartily in agreement with this point of view. Hurricanes are essentially oceanic phenomena occurring generally to the east of land masses

The fact that South America crowds north into the Caribbean may account for the interesting result Jordan obtains when he divides hurricanes into those born east and west of long 70° W The northernmost point of South America is at about this longitude West of this point the Caribbean approximates to an nland sea, east of it, one has an ocean open to the east One would not expect to find hurricanes forming in the two areas in exactly the same way, nor would one expect to find atmospheric tides behaving n the same way in both In this connexion, I would point out that if one divides hurricanes into a large enough number of classes, say, according to longitude at birth, one can certainly obscure any trace of a tidal force acting as a trigger within a given class

The arguments offered by Jordan do not seem to concern the validity of my reasoning based on the year-by-year count of hurricanes It would be helpful f a measure of magnitude were available for individual hurricanes, numbers alone do not tell the whole story. Also, there seems to be some question as to whether the available counts of hurricanes and typhoons can be considered reasonably complete For example, on examining the statistics, one suspects that more hurricanes have been found near steamer anes or near inhabited islands than in the open ocean The important activity of weather reconnaissance aeroplanes in recent years may easily have ncreased the average number of hurricanes discovered n a year

If it proves to be true that there is a tendency for two or more hurricanes to form at about the same time in areas widely separated in longitude, the tidal-force trigger concept will be strengthened I do not have at my disposal adequate observational material to carry out this investigation I hope that someone who has both the necessary data and the required mathematical background will look at this problem One remembers that 'Edna' 1954 was coming up along the Atlantic coast at the same time that a severe typhoon was moving in toward Okinawa and Japan. Later, when 'Hazel' 1954 was moving northward, another severe storm, perhaps of hurricane strength, was moving northward in the Atlantic Ocean a long way to the east of the United States east coast

If my estimates of phases and strengths of atmospheric tides are correct, 1955 and 1956 should be good years in which to study this tidal-force trigger concept.

CHARLES H SMILEY

Ladd Observatory,
Brown University,
Providence 12, R I

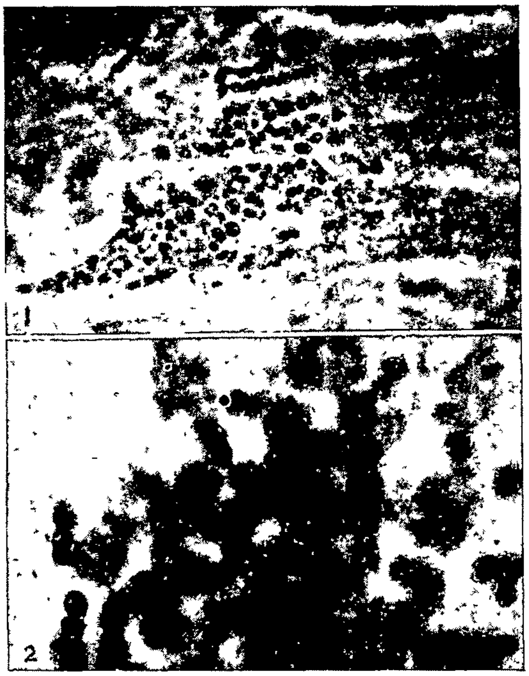
Cytoplasmic Granules in Fibrogenic Cells

A SYSTEMATIC investigation into the method of elaboration of intercellular material in connective and skeletal tissues has shown that cytoplasmic granules, which contain polysaccharide protein components, are present in fibrogenic cells of the fowl embryo both *in vivo* and *in vitro*

When tissue cultures of frontal bone, tendon or cornea are grown by the hanging-drop technique in a fibrin-free liquid medium and viewed in the living state by phase contrast, cytoplasmic granules of 0 7–2 μ in diameter are very conspicuous in the outgrowing cells. Time-lapse ciné-photography has been used to record their behaviour, the granules are seen to cluster around the nucleus and to be in continual motion in the cell processes, where they are often aligned in rows of several granules (Fig 1), they move independently of one another and generally along the axis of alignment Under the oil-immersion lens, the granules show the presence of a less dense centre and in some instances (within the limits of optical resolution) two or more granules appear to join together They persist throughout mitosis and are still plentiful when some intercellular material has been formed On application of janus green, the filamentous mitochondria take up the stain, whereas the granules remain colourless The granules are also stained supravitally by neutral red and gentian violet, which confirms the views of previous investigators[1].

Under the electron microscope, fibroblasts, osteoblasts and osteocytes cultivated directly on electron microscope grids and fixed by osmium tetroxide show granules (Fig 2) closely similar in appearance to those of the living cell, they are seen to have a diffuse margin and are less dense than the smaller, sharply defined lipid globules that are also present[2] Thin sections of cultures cut parallel to the surface of the migrating cells show variations of internal density in the granules, whereas the central zone sometimes appears as a separated region. Similarly, in thin sections of tissues from the embryo, the cytoplasmic granules in fibrogenic cells are seen to be non-homogeneous in structure

It has been found that the granules contain polysaccharide, since after fixation and extraction for



(1) Phase-contrast photomicrograph of part of an osteoblast growing from a living culture of frontal bone, showing the cytoplasmic granules, some of which are aligned in rows Part of the nucleus can be seen on the left of the photograph × 1,500

(2) Electron micrograph of part of a similar cell showing the diffuse periphery of the granules and the denser lipid globules Fixed by osmium tetroxide vapour × 8,000

lipids and glycogen, they remain intact and can be stained by the use of the periodic acid – Schiff technique In sectioned tissue the periphery of the granules appears to stain, while the centre remains colourless, the presence of a free aldehyde is excluded as the periodic acid–Schiff method gives a negative response without prior oxidation The polysaccharide may be acidic in nature, as a positive reaction is obtained by the dialysed iron procedure of Hale[3], but this method may not be highly specific On addition of metachromatic stains (toluidine blue, thionine) to living tissue cultures, the granules show the red–purple of metachromasia within three minutes, this may imply the presence of macromolecules with negative charges It is important to stress that in cultures grown in Tyrode solution alone the outgrowing cells from a tendon explant, for example, still show the presence of metachromatic granules, this would indicate that they have not absorbed metachromatic substances from the normal culture medium in which they are grown These factors suggest that part at least of the polysaccharide content of the granules is mucopolysaccharide In this connexion it is of interest that Gersh and Catchpole[4] have recorded barely resolvable intracellular granules in fibroblasts and postulated that they may be of a glycoprotein nature, and Heller-Steinberg[5] has suggested a similar component in frozen-dried preparations of metaphysial bone cells of the rat, and associated their presence with the deposition of new bone

That the granules contain some protein is suggested first by their ability to take up basic dyes such as eosin, and secondly by ultra-violet microscopy of the living tissues, where there is absorption at 280 mμ while there is no absorption at 313 mμ. In preparations stained by the May Grunwald–Giemsa (Jacobson and Webb[6]) and methyl-green pyronine methods for ribonucleoprotein and deoxyribonucleoprotein, or by the Feulgen technique for deoxyribonucleic acid alone, the granules give no specific staining reaction for either nucleoprotein, nor are the granules destroyed by digestion with ribonuclease or deoxyribonuclease for periods sufficient to remove the known content of ribo- or deoxyribonucleic acid from the cells On the other hand, in living tissue the granules absorb at 265 mμ, this may be due to spread resulting from the 280 mμ absorption, or may indicate the presence of a nucleoprotein which the staining techniques have failed to demonstrate and the nucleases have failed to remove However, so far as can be ascertained, both protein and polysaccharide are present in the same granule

The granules give an alkaline phosphatase reaction by the use of the Gomori–Takamatsu technique, which may well be correlated with the known phosphatase activity of fibrogenic tissue This suggests that enzyme activities may be localized within the granules, while the existence of other components cannot at this stage be excluded

As the cytoplasmic granules persist throughout all stages of growth of the tissue, it is reasonable to associate their presence with the elaboration of the intercellular material. It is therefore suggested that the polysaccharide and protein components of the granules may have fibrogenic properties, the granules may secrete, not necessarily continuously, a part or the whole of the ground substance, they may synthesize the collagen fibril itself, or they may contain precursors for the complex extracellular material. The method whereby the polysaccharide and protein components leave the cell is not yet clear, however, for in the living cell no extrusion of intact granules has been observed

I wish to express my thanks to Prof J T Randall and to Dr H B Fell for their advice and guidance, and to Dr J Chayen for the ultra-violet microscopy

S Fitton Jackson
Medical Research Council Biophysics Research Unit,
Wheatstone Physics Laboratory,
King's College, London, W C 2,
and
Strangeways Research Laboratory,
Cambridge Oct 5

[1] Fell H B, *J Anat*, 46, 11 (1932) Bast, T H, *Amer J Anat* 29, 139 (1921)
[2] Fitton Jackson, S, Int Conf of Electron Microscopy, London (1954)
[3] Hale, C W, *Nature*, 157, 802 (1946)
[4] Gersh, I, and Catchpole, H R, *Amer J Anat*, 85, 457 (1949)
[5] Heller-Steinberg, M, *Amer J Anat*, 89, 347 (1951)
[6] Jacobson, W, and Webb, M, *Exp Cell Research*, 3, 163 (1952)

Source of the *Phlei* Growth Factor for *Mycobacterium johnei*

It was first shown by Twort and Ingram[1] that extracts of *Mycobacterium phlei* and certain other acid-fast bacilli contained a growth factor essentia for the laboratory cultivation of *Mycobacterium johnei* They[2] also obtained growth of *M johnei* on media containing alcoholic extracts of certain food materials of cattle Since extracts of organs of cattle did not contain this factor and since the principa lesions of Johne's disease are confined to the intestine they concluded that food was the probable source of the growth factor *in vivo* Francis *et al* [3], however obtained only a very slight stimulation of growth with some extracts of food materials, a stimulation which they considered to be due probably to sub stances unrelated to the growth factor; other extracts gave completely negative results. In all this work a form of inspissated egg was used as the basal medium.

Since it was thought possible that either substances present in food might be altered by enzyme or bacterial action in the gut to growth factor, or that the bacteria normally present there might be a source of that substance, it was decided to repeat and extend the observations of these two groups of workers. This study was facilitated by the availability of modifications[4] of Dubos's media suitable for the cultivation of *M. johnei*.

Materials to be examined were first dried in a desiccator and then extracted with ethanol in a manner similar to that used for extracting *M. phlei*[4]. Each extract was added to media in two-fold falling amounts, the highest final concentration in the media being the equivalent of 100 per cent of the dried material before extraction, and the lowest 1.5 per cent. Aqueous extracts of the dried materials were also studied and, in some cases, fresh unheated Seitz-filtered extracts. The basal media employed were the modifications[4] of the liquid and solid media of Dubos and egg media, to none of which had *M. phlei* extract been added. Two strains of *M. johnei* were used as indicator strains. These would not grow at all on media devoid of *phlei* extract. They were lightly inoculated on to media under test, and incubation was carried out at 37° C. for six months. Extracts of the following were examined.

(1) Muscle, liver, pancreas, mesenteric and bronchial lymph nodes, intestinal wall, rumen contents and intestinal contents of ten healthy cows. The diet of five of the cows for some time before slaughter had consisted mainly of fresh grass. The others had been fed on hay, kale and various concentrates.

(2) Rumen contents, intestinal contents and mesenteric lymph nodes of two cows that had died from Johne's disease.

(3) Broth cultures of rumen and intestinal contents of two healthy cows and two that had died of Johne's disease.

(4) Intestinal contents of three sheep, three pigs, three horses and three rabbits.

(5) Five specimens of commercial dried grass meal, five of fresh grass, three of milk and two of oats, wheat, lucerne, clover, kale and hay.

No visible growth of *M. johnei* occurred on media containing any of these extracts.

These results do not support the view of Twort and Ingram that food materials are the probable source of the growth factor *in vivo*. It is more probable that the production of this factor is restricted to acid-fast bacilli and that, as suggested by Francis *et al.*, *M. johnei* does not require a supply of growth factor from an external source when growing *in vivo*, but can synthesize it as adapted strains do *in vitro*. This observation is of significance when the control of Johne's disease is considered.

H. WILLIAMS SMITH

Animal Health Trust,
Houghton Grange,
Huntingdon. Aug. 25.

---

[1] Twort, F. W., and Ingram, G. L. Y., "Johne's Disease" (Baillière, Tindall and Cox, London, 1913).

[2] Twort, F. W., and Ingram, G. L. Y., *Zbl. Bakt.* (Abt. 1, Orig.), 73, 277 (1914).

[3] Francis, J., Macturk, H. M., Madinaveitia, J., and Snow, G. A., *Biochem. J.*, 55, 596 (1953).

[4] Williams Smith, H., *J. Path. Bact.*, **66**, 375 (1953).

Effect of Vitamin A Deficiency on the Cerebro-spinal Fluid Pressure of the Chick

ANIMALS reared on a diet deficient in vitamin A suffer from a syndrome characterized by the appearance of muscular inco-ordination and weakness, followed by paresis, fits and finally death[1]. This condition occurs in poultry, and has been regarded either as a primary disorder of the central nervous system[2], or alternatively as produced by the compression of a normally growing nervous system by an abnormally growing skeleton[3]. In a preliminary series of experiments, we repeated the work of Wolbach and Hegsted[3], using a diet containing no detectable provitamin A. During the course of these experiments, we found that the cerebro-spinal fluid pressure in the experimental chicks was considerably raised (180–200 mm. of water) as compared with that of a group of control chicks on the same diet with the addition of an adequate supply of vitamin A (90–105 mm. of water).

Further experiments were designed to determine more accurately the relationship between the cerebro-spinal fluid pressure and hypovitaminosis A. Day-old chicks were placed on the following diet: white maize 56 parts, wheat middlings 25, casein 12, dried yeast powder 4, calcium carbonate 1, bone flour 1, salt 1. 180 B.S.I. units of vitamin D_3 was added to each pound of the mash, and the diet was also supplemented with vitamin K and riboflavin. This diet contained 1.6 p.p.m. of carotene. The chicks were weighed twice weekly and showed normal gain of weight. Cerebro-spinal fluid pressure measurements were made on these chicks at various ages and the results are shown in Table 1.

Table 1

Age of chicks in days	No. examined	Mean pressure of cerebro-spinal fluid (mm. water) Standard error in brackets
30	4	108 (16.8)
62	21	157 (7.3)
88	7	180 (12.6)
125	3	212 (19.3)

(Standard errors are based on a pooled estimate of variance within groups.)

Measurements on ten normal chicks of comparable ages confirmed that the average pressure of the cerebro-spinal fluid in the healthy chick is less than 100 mm. of water[4]. Thus the cerebro-spinal fluid pressure in the experimental chicks was raised well above normal values. A statistical analysis of the results showed that there was a constant rate of increase of pressure with age, of estimated amount 1.03 mm. per day with standard error 0.243 (31 degrees of freedom, $P < 0.001$). None of the experimental chicks showed any visible signs of neurological disease at the time when the cerebro-spinal fluid pressure was measured, and at necropsy no bony abnormality was found.

Raised cerebro-spinal fluid pressures in vitamin A deficiency have previously been reported in the calf[5], the sheep[6], and the pig[7]. These findings, together with those reported above, indicate that a raised cerebro-spinal fluid pressure is one of the earliest manifestations of vitamin A deficiency in experimental animals, and that it may make its appearance before any overt sign of neurological disturbance becomes evident.

This work was supported by a grant from the Nuffield Foundation. We wish to thank Mr. H. E.

Daniels for the statistical analysis, and Miss M Ellington for technical assistance

D H M WOOLLAM
J W MILLEN

Department of Anatomy,
University, Cambridge
Sept 21

[1] Hughes, J S, Lienhardt, H F, and Aubel, C E, *J Nutrition*, **2**, 183 (1929)

[2] Rigdon, R H, *Arch Path*, **53**, 239 (1952)

[3] Wolbach, S B, and Hegsted, D M, *Arch Path* **54**, 13 (1952)

[4] Griffith, J Q, and Farris, E J, "The Rat in Laboratory Investigation", Chapter 9 (Lippincott, Philadelphia, 1942)

[5] Moore, L A, and Sykes, J F, *Amer J Physiol*, **130**, 684 (1940)

[6] Eveleth, D F, Bolin, D W, and Goldsby, A I, *Amer J Vet Res*, **10**, 250 (1949)

[7] Sorensen, D K, Kowalczyk, T, and Hentges, J F, *Amer J Vet Res*, **15**, 258 (1954)

Carotenogenesis in *Haematococcus pluvialis*

IN a recent communication[1], Goodwin and Jamikorn state that light is necessary for the synthesis of astaxanthin, the carotenoid responsible for the red colour in the alga *Haematococcus pluvialis* It is not clear whether this conclusion is reached as a result of their own experience or whether they are referring to earlier information[2] In my opinion the conclusion is erroneous, for the following simple experiment convincingly demonstrates that dark synthesis is possible The medium consists of 50 mgm /l soil extract (1 per cent v/v of an extract yielding 5 gm dry-weight of humic substance per litre on acidification), containing an amount of metabolizable nitrogen equivalent to 5 mgm /l potassium nitrate, and is enriched with 500 mgm /l anhydrous sodium acetate A single green motile cell placed in 6 ml. of this medium multiplied, in complete darkness at 13–18° C. with a relative growth-rate ($\log_2$ increase per day) of 0 55–0 6, to a maximum of $2^{14\,3}$ cells per ml in thirty days, further increase being prevented by nitrogen depletion At this juncture the cells were still motile and green Astaxanthin first became visible in the cells on microscopic examination fourteen days later, that is, on the forty-fourth day of the experiment Encystment was complete after a further ten days, by which time enough astaxanthin had accumulated for the cells to appear bright orange to the naked eye

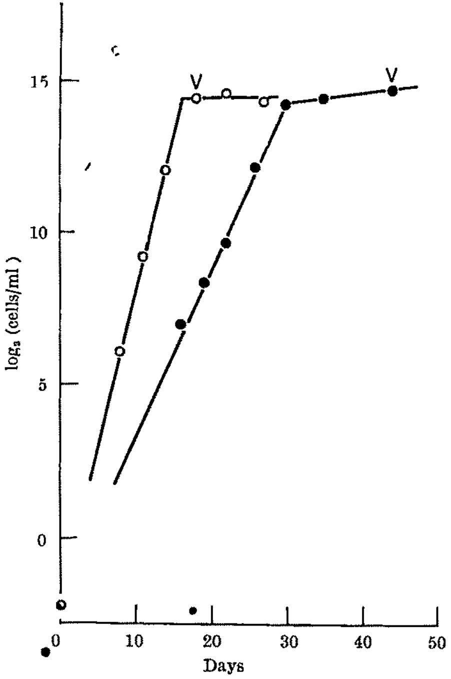


Fig 1 Growth of *H pluvialis* from a single cell in the soil extract medium with 500 mgm /l sodium acetate Open circles, in the light, closed circles, in the dark The arrow-heads indicate the first appearance of the carotenoid in the cells on microscopic examination

A comparison of these rates with those obtained in identical media in the light reveals quantitative differences (Fig 1) In the light, the carotenoid first appears not more than two days after the completion of growth For clear-cut results, conditions have to be such that exponential increase continues to the point when nitrogen becomes limiting, a condition which is met by the medium quoted The relative growth-rate in this medium, with a light intensity of 100 ft candles and with carbon dioxide remaining in equilibrium with the atmosphere, is about double the dark-rate On the other hand, the rate of astaxanthin synthesis, estimated on the time interval between arrest of growth and first appearance of the carotenoid on microscopic examination, appears to be some seven times greater in the light

However, a mere difference in magnitude between the ratios of the two rates is insufficient to prove that light is necessary for astaxanthin synthesis, or, indeed, has any action other than indirectly through the photosynthetic apparatus

It is important to stress that dark synthesis can be overlooked for the reason that, when comparing light- and dark-cultures of the same age, the light-culture is invariably more advanced than the dark and so reaches the point at which the accumulation of the red carotenoid begins (that is, when cell-division ceases) much sooner than the other

M R DROOP

Marine Station,
Millport, Scotland
Sept 15

[1] Goodwin, T W, and Jamikorn, M, *Biochem J*, **57** (3), 376 (1954)

[2] Lwoff, M, and Lwoff, A, *C R Soc Biol Paris*, **105**, 454 (1930)

Saccharides of Different Varieties of Indian Rice

THE saccharides of seven rice samples (*Oryza sativa* Linn), including some old ones that are in common domestic use, have been investigated, with the view of correlating the carbohydrate changes in stored rice with the nutritive value and taste Four kinds of raw rice (basmati) and three types of parboiled rice (saila) were chosen (basmati and saila are the local names for raw and parboiled rice respectively in northern India) Among the raw rice were included two one-year old samples, one new sample and a fourth that had been stored for three years in tins (30 ± 5° C) The parboiled rice consisted of the varieties Burdhwan, Mainpuri and Patna

Circular paper chromatographic technique, as described by Giri and Rao[1], was adopted The resolution of the saccharides was effected by spotting 50 µl of the water extract of each sample on the circumference of a circle drawn at the centre of a circular Whatman No. 1 filter paper (33 0 cm diam) Along these were also run a mixture of known sugars, including maltotriose and maltotetraose, recently isolated by Whistler and Hickson[2] from corn syrup

Table 1

Sugars	Known mixture	Raw rice				Parboiled rice		
		Basmati 1 yr old B_1	Basmati 1 yr old B_2	Basmati new B_3	Basmati 3 yr old B_4	Saila 1 yr old (Burdhwan) S_1	Saila 3 yr old (Mainpuri) S_2	Saila 1 yr old (Patna) S_3
Fructose	1.0	1.10	1.11	1.11	1.09	1.09	1.10	1.10
Glucose	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Galactose	0.93	0.93	0.92	–	0.90	0.91	0.90	0.91
Sucrose	0.80	0.80	0.79	0.79	0.78	0.79	0.80	0.79
Maltose	0.70	0.69	0.69	–	0.64	0.64	0.64	0.65
*iso*Maltose	–	–	–	–	0.54	–	0.54	–
Raffinose	0.51	0.52	0.52	–	0.50	0.50	0.50	0.51
Maltotriose	0.51	0.52	0.51	–	0.50	0.50	0.50	0.51
Maltotetraose	0.40	–	–	–	0.40	–	0.40	–

After irrigating the chromatogram with *n*-butanol – acetic acid – water[3] (40:10:50) for 16 hr., the sugars were located by spraying with aniline-diphenylamine phosphate[4]. The separation of various sugars is shown in Fig. 1, and Table 1 represents the corresponding R_G values.

The *iso*maltose bands in B_4 and S_2 were yellowish-brown in colour, similar to glucose, but quite distinct from the blue colour given by maltose, maltotriose and maltotetraose. Raffinose bands were brown, and those containing a mixture of raffinose and maltotriose dirty-blue. The tri- and tetra-saccharide bands were further confirmed by eluting them with water from a separate chromatogram, hydrolysing with 0.5 *N* sulphuric acid and subsequent neutralization with barium carbonate.

Mixed chromatograms were run with the test samples and the known sugars using *n*-butanol – acetone – water (20:70:10) as the developing solvent.

It is interesting to note that no *iso*maltose, maltotriose and maltotetraose were detected by Williams and Bevenue[5] in American-grown rice samples. This seems to have been due to the fact that their rice samples were not so old, and no enzymatic degradation of starch had taken place.

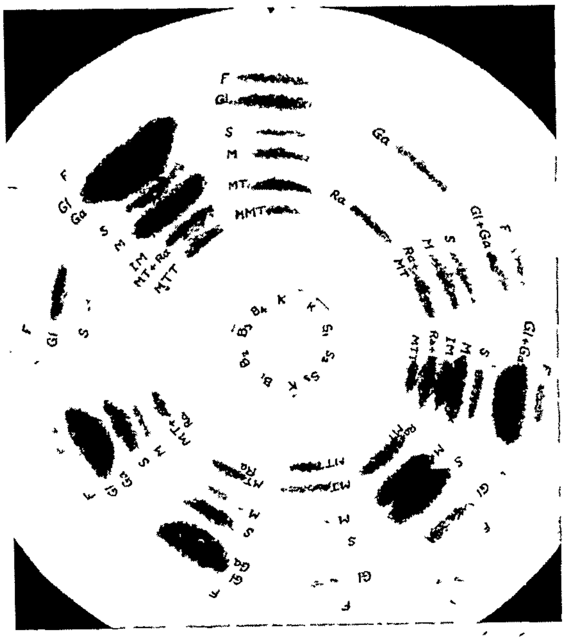


Fig. 1. Circular paper chromatogram showing the separation of saccharides of different rice samples. *K*, known sugars; *F*, fructose; *Gl*, glucose; *Ga*, galactose; *S*, sucrose; *M*, maltose; *IM*, *iso*maltose; *Ra*, raffinose; *MT*, maltotriose; *MTT*, maltotetraose

It has been observed that fructose, glucose, galactose and sucrose are common in almost all varieties of rice. Galactose is not detected in new raw rice. Raffinose is more abundant in parboiled rice (saila). Storage results in the production of a greater proportion of these lower saccharides. The formation of maltose, *iso*maltose, maltotriose and maltotetraose in old samples is possibly due to the action of α-amylase on starch.

These changes in old rice may contribute towards its improved digestibility and better taste, in conformity with the views of Sahasrabuddhe and Kibe[6].

Thanks are due to Dr. R. L. Whistler, of Purdue University, United States, for kindly supplying maltotriose and maltotetraose.

D. B. PARIHAR

Defence Science Laboratory,
Hillside Road,
New Delhi.
Aug. 9.

[1] Giri, K. V., and Rao, N. A., *Nature*, 169, 923 (1952); *J. Ind. Inst. Sci.*, 34, 95 (1952).
[2] Whistler, R. L., and Hickson, J. L., *J. Amer. Chem. Soc.*, 76, 1671 (1954).
[3] Partridge, S. M., *Biochem. J.*, 42, 238 (1948).
[4] Giri, K. V., and Nigam, V. N., *Naturwiss.*, 40, 343 (1953).
[5] Williams, K. T., and Bevenue, A., *Cereal Chem.*, 30, 267 (1953).
[6] Sahasrabuddhe, D. L., and Kibe, M. M., *Ind. J. Agric. Sci.*, 5, 12 (1935).

Shikimic Acid in Grass

IN a paper describing, *inter alia*, the isolation of quinic acid from grass[1], it was suggested that one of the acids (termed 'acid *B*') present in the grass extracts might be shikimic acid or a closely allied acid. Acid *B* appeared to be identical with 'acid *G*' found by Davies and Hughes[2] in grass and stated by them to be a monobasic acid of relatively high molecular weight. At the time, only a few milligrams of acid *B* was available in solution, and comparison by paper chromatography with authentic shikimic acid showed that the two acids had the same R_F in butanol – formic acid – water, but in benzyl alcohol – *tert*-butanol – *iso*-propanol – formic acid – water and propanol – ammonia – water the mixed acids gave two spots of closely similar R_F value.

Upwards of 100 mgm. of acid *B* has now been obtained from extracts of a pure strain of grass (*Lolium perenne*) dried at 80° C. in a current of air. This specimen had a melting point of 183–184° C. (corrected), mixed melting point with authentic shikimic acid (kindly supplied by Dr. H. O. L. Fischer) 184–184.5° C. (corrected). The elementary analysis gave C, 47.9; H, 5.65 per cent; calculated for shikimic acid, C, 48.3; H, 5.79 per cent. Molecular weight by titration, calculated as a monobasic acid, was 172.6; shikimic acid has a molecular weight of

174 0 $[\alpha]^{20}_{D}$ for acid *B* was found to be $-$ 179 5° (water, 20 mgm in 0 5 ml), Eijkman[3] gives $[\alpha]^{18}_{D}$ for shikimic acid as $-$ 183 8° (water, C = 4 03 per cent)

Acid *B* and shikimic acid gave identical R_F values (alone and mixed) in the three solvent systems mentioned above It has now been shown that the two spots of closely similar R_F values found previously for acid *B* and shikimic acid were due to contamination of acid *B* with glyceric acid, some, at least, of which was probably formed by the action of the anion exchange resin on the sugars of the original grass extracts during the separation of the acids We have found that even weakly basic anion exchange resins such as 'Deacidite G' react in the 'OH' form with sugars to give several acids, including glyceric acid, which has an R_F value similar to shikimic acid in the three solvent systems used In the present work this difficulty was overcome by using 'Deacidite *G*' in the acetate form for the separation of the acids from the sugars in the grass extracts freed from amino-acid

It is now beyond doubt, therefore, that acid *B* of grass is shikimic acid Work is proceeding on the isolation of the other unidentified acids in the grass extracts, and the results will be reported in detail elsewhere

A. RICHARDSON

Edward Davies Chemical Laboratories,
University College of Wales,
Aberystwyth

A C HULME

Ditton Laboratory,
Food Investigation Organization
(Department of Scientific
and Industrial Research),
East Malling, Maidstone, Kent
Sept 16

---

[1] Hulme, A C, and Richardson, A, *J Sci Food and Agric*, 5, 221 (1954)

[2] Davies, C W, and Hughes R B, *J Sci Food and Agric*, 5, 200 (1954)

[3] Eijkman, J F, *Ber dtsch chem Ges*, 24, 1278 (1891)

Effect of α-Naphthalene Acetic Acid on Yield of Indian Cotton

REDUCTION in boll shedding was noticed when injuries to the cotton plant were reported as a result of spraying with 2,4,dichlorophenoxy acetic acid[1] Depletion of non-reducing sugars and accumulation of proteins and amino-acids are common effects of several synthetic hormones[2]. Applications of α-naphthalene acetic acid and certain other growth regulators have been found to effect an increase in the setting percentage of bolls and yield of seed cotton[3] The effects of the applications of these hormones on photosynthetic activity and fruiting with enhanced carbohydrate–nitrogen metabolism in the cotton plant have been recently studied[4]

Most of these observations were made on American or other exotic varieties of cotton A preliminary investigation on the effects of α-naphthalene acetic acid on the carbohydrate changes in the leaves and yield of seed cotton of Dhar 43 (an improved strain of Bhoj, *Gossypium arboreum*) was undertaken during the 1953–54 cotton season An attempt was made to find whether the application of α-naphthalene acetic acid as a spray on desi (Indian) cotton plants would prove beneficial at the active stage of vegetativ growth or at the onset of the reproductive phase The hormone was applied in three doses, of 10, 2 and 30 parts per million

Table 1

Treatment	Yield of seed cotton (lb per acre)	Increase over control	Increase (per cent)
Control	466 2	—	—
Early spray at the active stage of vegetative growth			
10 p p m	567 0	101 4	21 75
20 p p m	537 6	71 4	15 31
30 p p m	516 6	50 4	10 81
Late spray at the commencement of reproductive phase			
10 p p m	582 6	116 4	24 96
20 p p m	593 2	127 0	27 24
30 p p m	569 1	102 9	22 07

Standard error of response over control, 45 8, significant differenc 97 5

Carbohydrate–nitrogen status in the leaves of th plants receiving late spray was higher at certai stages of growth than all other early spray treatment and the control Also, there appears to be mor effective carbohydrate utilization by plants receivin late spray, because of their comparatively highe yield of seed cotton than any other early spra treatments

Early spray of 10 p p m of α-naphthalene aceti acid and all the three late-spray treatments showe statistically significant increase in the yield of see cotton over the control Percentage increases i yield were more in late-spray treatments than i early-spray treatments

These observations are being extended for con firmation and will be published in detail elsewher

We are grateful to Prof R H Dastur, plan physiologist for the Scheme for Cotton Physiologic Research, Indian Central Cotton Committee, fc guidance, the financial support of the Committee fc this investigation is also acknowledged

JAYENDRA BHATT
R V DATE

Scheme for Cotton Physiological Research,
Institute of Plant Industry,
Indore
Aug 16.

---

[1] Brown, C A, *Amer J Bot*, 34, A, 20 (1947) Dunlap, A A, *Phyt path*, 38, 631 (1948) Staten, G, *J Amer Soc Agron*, 38, 5 (1946)

[2] Ergle, D R, and Dunlap, A A Texas Agric Exp Sta Bull 7 (1949) Weller, L F, Sell, H M, Lucke, L W, Taylor, B and Hamner, C L, *Plant Physiol*, 2 A, 295 (1949)

[3] Sucha Singh and Gruelack, V A, *Amer J Bot*, 36, 646 (194 Prakash, V, M Sc. thesis, University of Bombay (1952)

[4] Bhatt J, M Sc thesis, University of Bombay (1954)

Distribution of *Pelmatohydra oligactis* (Pallas) in Scotland

SINCE 1918, *Hydra vulgaris attenuata* and *Hyd vulgaris vulgaris* have been cultivated in the Not Dame Laboratory for teaching purposes Ve occasionally these cultures have had to be replenishe from outside sources. It was not until 1946 that noticed the occurrence of *Pelmatohydra oligact* which I felt sure had been introduced in materi obtained from a dealer in the south of Englan The *Hydra vulgaris vulgaris* were completely oust by the rapid spread of *Pelmatohydra oligactis* October 1947 all the specimens were reproduci luxuriantly , even small individuals were covered with testes After this efflorescence, the organisms gave place to *Hydra vulgaris vulgaris*

Although our collecting was by no means exhaustive, and was not primarily for hydra, yet we never recorded *Pelmatohydra oligactis* in our catches. Indeed, I had concluded from laboratory observations that this species required a warmer temperature than that of the Glasgow area It was a great surprise, therefore, to be shown by Mr A MacKinnon (of the Zoology Department, University of Glasgow) a catch of *Pelmatohydra oligactis* obtained by his collectors from water-weeds of a Milngavie pond The circumstantial evidence points to the fact that the species has spread to Scotland Unfortunately, records of the occurrence of *Hydra* in Scotland are not easily obtainable I should be grateful for information of the existence of *Pelmatohydra oligactis* in Scotland before 1940

Monica Taylor

Notre Dame College,
Glasgow

Sept 29

Enhanced Light Absorption by Compounds in Chromatograms

We have investigated some characteristics of a hyperchromic absorption of light that takes place when a compound in dry chromatographic paper is transilluminated with radiation of absorbable wavelength. Laurence[1] has previously noticed and interpreted such enhanced absorption, but no results were presented, and the phenomenon has escaped general recognition It is a true[2] absorption, and not a manifestation of varying spatial distribution of the transmitted light All evidence indicates that it is caused by transit of photons through dry paper via paths longer than rectilinear lines directly through the paper and the layer of absorbing compound therein Multiple refractions augment the effective optical depth in the manner described by Keilin and Hartree in photometric studies of compounds in devitrified frozen solvents[3]

To evaluate true absorption of ultra-violet light without interference from effects of variable geometrical distribution of the transmitted light, several techniques were applied and found to yield the same results A fluoroscopic photometer[4] was applied in some instances because it intercepts and responds uniformly to the total light transmitted by a papergram For application of other detecting systems, dry Whatman No 50 paper sealed in polyethylene was used to scatter randomly the incident light or transmitted light, or both , the diffuse transmission pattern resembles that of visible light on passage through opal glass[5]

That the hyperchromic absorption is dependent upon light refraction was established by saturating papergrams with oil ('Nujol') and other liquids of refractive index approaching that of cellulose, c 1 5 The absorption of 254 $m\mu$ light was diminished by a factor close to one-third (Figs 1 and 2), and was restored on removal of impregnating fluid by evaporation or by washing with an appropriate volatile solvent Restoration of hyperchromic absorption during evaporation of a volatile liquid was followed kinetically and found to occur simultaneously for several deposited compounds and for absorbing constituents of the paper itself Time curves for increased absorption parallel those for increased scattering of collimated light away from the line of incidence

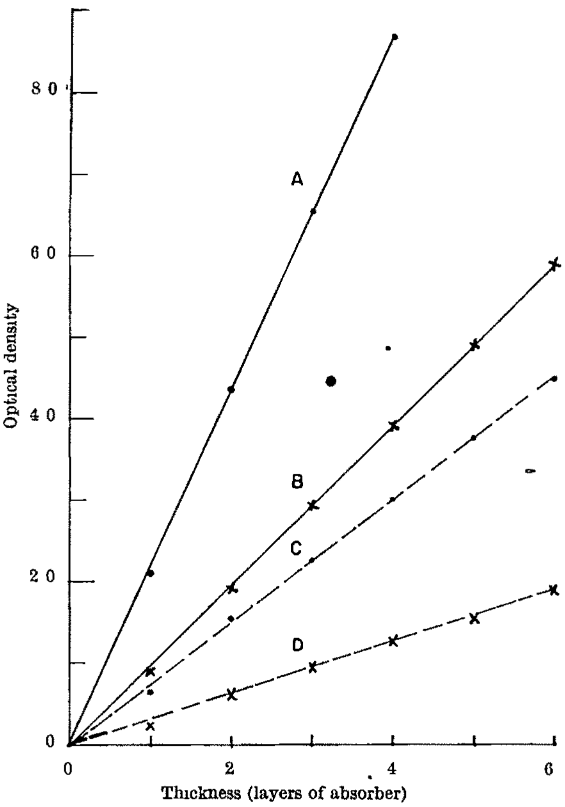


Fig 1 Absorption of light of 254 $m\mu$ as a function of thickness of absorber (*A*) Adenylic acid layer 16 millimicromoles per sq cm thick in dry Whatman No 11 paper , (*B*) dry Whatman No 11 paper , (*C*) adenylic acid of same thickness in oiled paper , (*D*) oiled paper

Typical findings for absorption of light of 254 $m\mu$ are shown in Fig 1, where density was measured with an extremely sensitive photon counter designed for chromatographic densitometry[4] With I_0 at 5,000 photons per sec without absorber, the absorbing layers were inserted between a source of diffuse monochromatic light and the detector Whenever the intensity of light transmitted to the detector decreased to less than 50 photons per sec , the initial photon flux was restored by adjusting intensity of incident light, and the measured density of 2 0–3 0 was added to subsequent values Absorption by constituents normally present in chromatographic papers and by deposits[4] of adenylic acid is seen to follow the Lambert–Beer law

$$\text{Optical density} = E = \log_{10} I_0/I = kt \qquad (1)$$

For absorption per layer of absorber, t represents the number of thicknesses or sheets. To consider absorption of deposited compounds on a molar extinction basis, the thickness is conveniently expressed in dimensions of mass and area[6,7], thus

$$\text{Thickness } (M/1{,}000 \text{ cm}^{2}) = \text{length (cm)} \times \text{concentration } (M/1{,}000 \text{ cm}^{3}) \qquad (2)$$

If dry chromatographic paper is used, the constant, k, may be regarded as a molecular extinction coefficient, ε_s, for a compound in a diffusely scattering matrix While the value of this coefficient is dependent upon properties of the standard matrix used and diminishes in magnitude as the thickness of

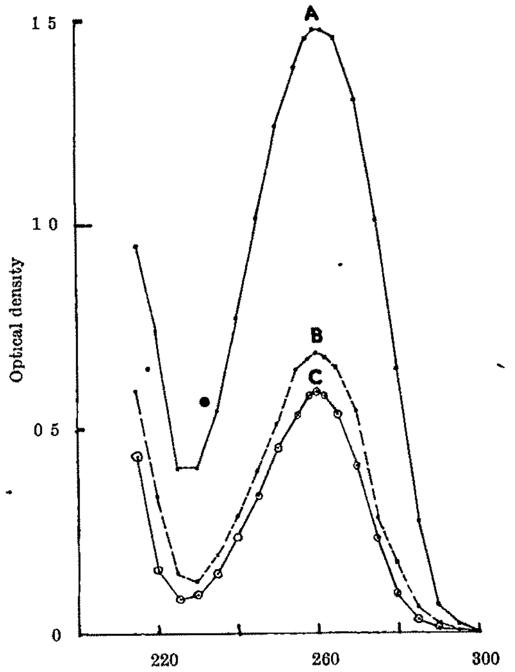


Fig 2 Spectral absorption curves of adenylic acid in paper and solution Thickness of nucleotide, 40 millimicromoles per sq cm (*A*) In dry Whatman No 50 paper, (*B*) in oiled Whatman No 50 paper, (*C*) in neutral aqueous solution

deposit per sheet of paper increases, studies to be presented in a detailed report show a simple relationship to the conventional molar absorption coefficient

E_{254} for a single sheet of dry Whatman No 11 paper is shown to be 1 0 in Fig 1 Corresponding values for Whatman papers No 1, 50, 3*MM* and 3 are 1 3, 1 3, 2 0 and 2 4 respectively For a 16 millimicromole per sq cm layer of adenylic acid in neutral Whatman No. 11 paper, Fig 1 shows that E_{254} is 1 19, and the ε_{s254} is calculated to be 74,000 This exceeds by a factor of 5 2 the value of ε_{254} for adenylic acid in neutral aqueous solution[8]

Conformity of the density to thickness relationships of Fig 1 with the Lambert–Beer law contrasts sharply with results of studies[4,9] wherein multiple thicknesses of absorber were evaluated in single sheets of chromatographic paper Departure from linearity under the latter condition occurs with use of monochromatic light, and is adequately explained on two bases the fractional diminution of optical density due to the presence of relative holes and valleys in a single sheet of paper becomes greater as the average density increases, an effect which is small with papers that are thick, uniform and dry, a second and fundamentally important basis is inherent to the three-dimensional absorption inevitable in a diffusely scattering matrix A linear increase of density with thickness (Equat 1) is theoretically tenable only if each increment of absorber exerts no influence on the fraction of incident photons absorbed by the other layers Such an influence is exerted when successive layers of absorber are added to a single diffusely scattering matrix, that is, a single sheet of chromatographic paper At small thicknesses (Equat 2) of absorber, the average path-length of transmitted photons must be nearly three times the linear distance through the paper due to equal excursions into the two dimensions of the plane of the paper Multiple reflexions from surfaces and total reflexions inside fibres of the paper may further augment the path-length By preferential removal of those photons which are scattered over the paths of greater length, each increment of absorber must shorten the average photon path through all subsequent increments To an ever-increasing extent, the transmitted photons will be members of the small fraction which, in the process of diffuse scattering, happens to be directed along the shortest paths through the paper Hence, the ΔE due to each Δt will become smaller as E increases

While the foregoing considerations preclude rigorous linearity of density to thickness plots for compounds in the form of deposits in a single sheet of paper, empirical relationships can be established with high precision. Reported methods for securing rectified plots[9,10] are of some value, but fail when applied over wide ranges of absorber thickness

Absorption by adenylic acid as a function of wave-length (Fig 2) was estimated with conventional techniques Removal of collimated incident light by the nucleotide was determined by comparison with a blank using the Beckman spectrophotometer with the 4,300 photomultiplier attachment Investigation of other compounds shows that hyperchromic absorption occurs throughout the ultra-violet and visible spectra

Full implications of hyperchromic absorption in chromatographic densitometry remain for future appraisal It is quite constant under standardized conditions, and appears to be a useful property if recognized

This work was aided by a grant from the United States Atomic Energy Commission

T D Price
P B Hudson
D F Ashman

Departments of Biochemistry and Urology,
and the Institute of Cancer Research,
Columbia University College
of Physicians and Surgeons,
and Francis Delafield Hospital,
New York 32, N Y

Aug 23

[1] Laurence, D J R, *J Sci Instr*, 31, 4, 137 (1954)
[2] Heller, W, and Vassey, E, *Phys Rev*, 63, 65 (1943)
[3] Keilin, D, and Hartree, E F, *Nature*, **165**, 504 (1950)
[4] Price, T D, and Hudson, P B, *Anal Chem*, 26, 1127 (1954)
[5] "International Critical Tables", 5, 265 (McGraw-Hill, New York, 1929)
[6] Glasstone, S, "Sourcebook on Atomic Energy", 152 (D Van Nostrand, New York, 1950)
[7] Sinsheimer, R L, Scott, J F, and Loofbourow, J R, *J Biol Chem*, **187**, 299 (1950)
[8] Volkin, E, and Cohn, W E, in Glick's "Methods of Biochemical Analysis", 1, 287 (Interscience Publishers, Inc, New York, 1954)
[9] Crook, E M, Harris, H, Hassan, F, and Warren, F L, *Biochem J*, 56, 434 (1954)
[10] Goldenberg, H, *Anal Chem*, 26, 690 (1954)

Adsorption of Glucose on a Weakly Basic Anion-Exchange Resin

ALTHOUGH furfural[1] is adsorbed on the weakly basic anion-exchange resin 'Amberlite *IR-4B*', the adsorption of sugars has not been reported, in fact, this resin has been used to de-ionize solutions prior to the estimation of sugars[2]. However, following the detection of traces of sugars in the acid fraction from fruit extracts, it has now been found that as much as 1 per cent of the glucose passed through a column of 'Amberlite *IR-4B*' may be adsorbed on the resin.

In studying the adsorption of sugars, two synthetic mixtures of sugars and acids were passed through small columns (5 gm. air-dry resin) of 'Amberlite *IR-4B*' One column had been used many times to collect acids from fruits, the other was freshly packed from a different batch of resin The mixtures of sugars (glucose, fructose and sucrose) and acids (malic, citric, quinic, galacturonic and phosphoric[3]) were similar in composition to those obtained after removing the cations from extracts of pears and peaches. The aliquot used for each experiment contained two or four milli-equivalents of mixed acids and 3 gm of sugars including 0 4 or 2 6 gm of sucrose Following the passage of the sugars and acids, the column was washed with water The first 100 ml was discarded The rest of the washings was collected in fractions some of which were concentrated (usually 100 1) under reduced pressure for paper chromatography

All the fractions run on paper gave a good glucose spot, even after the column had been washed with two litres of water In the case of the mixture with the high sucrose concentration, early fractions gave a good sucrose spot, otherwise only traces of sucrose and fructose were detected All fractions contained quinic or galacturonic acid, or both, depending on their relative proportions in the mixture , the other (stronger) acids were not detected Similar results were obtained with both columns, with rates of washing varying from 0 25 to 2 ml per minute, and after regeneration of the resin with 2 *N* ammonia or 2 *N* sodium carbonate

Some quantitative work was done using solutions of glucose Aliquots were run through the columns, followed by 200 ml of water and then by 50 ml 2 *N* ammonia or 50 ml 2 *N* hydrochloric acid. The water wash recovered 98–100 per cent of the glucose used, the ammonia a further 0 01–0 1 per cent, the acid a further 0 3 per cent Successive washings with 2 *N* hydrochloric acid, allowing the acid to stand on the column, eluted altogether 0 7–1 0 per cent of the glucose used The glucose was estimated by reaction with anthrone[4], using a solution of glucose in 2 *N* hydrochloric acid as a standard in appropriate cases It was necessary to wash the new column thoroughly with 2 *N* hydrochloric acid to obtain a satisfactory blank

Technical assistance by Mr J W Steel and Mr J H Curtin is gratefully acknowledged

T M REYNOLDS

Division of Food Preservation and Transport,
Commonwealth Scientific and
Industrial Research Organization,
Homebush, N S W
June 17

[1] Gabrielson, G , and Samuelson, O , *Acta Chem Scand* , 6, 729 (1952)

[2] Williams, K T , Potter, E F , Bevenue, A , and Scurzi, W R , *J Assoc Off Agric Chem* , *Wash* , 32, 698 (1949) Laidlaw, R A , and Reid, S G , *J Sci Food and Agric* , 1, 19 (1952)

[3] Anet, E F L J , and Reynolds, T M , *Nature*, 172, 1188 (1953)

[4] Fairbairn, N J , *Chem and Indust* , 86 (1953)

Energy of Activation for the Acid-catalysed Hydrolysis of Esters

ACTIVATION energies of the order of 30 kcal /mol have been found for the acid-catalysed hydrolysis of *tert* -butyl 2 4 6 trimethylbenzoate and *tert* -butyl benzoate, for which the reaction has been shown to proceed by alkyl–oxygen fission[1], and of *tert* -amyl 2 4 6 trimethylbenzoate, *tert* -amyl benzoate, diphenylmethyl 2 4 6-trimethylbenzoate and α-methylallyl 2 4 6-trimethylbenzoate, where the same mode of fission may be predicted This value is significantly higher than that found for the hydrolysis of esters by acyl–oxygen fission, and seems to be characteristic of this mechanism

The rate of hydrolysis with acyl–oxygen fission increases markedly from benzoates to acetates, and the transition in mechanism would be expected to occur in the region of *tert* -butyl acetate This appears to be the case, for the Arrhenius equation is not followed in the hydrolysis of *tert* -butyl acetate, the activation energy varying from 26 to 30 kcal./mol between 50° and 100°, which implies, however, predominantly alkyl–oxygen fission, in agreement with the results of Bunton, Comyns and Wood[2] Preliminary experiments on *tert* -butyl formate give an activation energy of *c* 16 kcal /mol , which is normal for the acyl–oxygen fission of esters of aliphatic acids This is consistent with the behaviour of diphenylmethyl formate mentioned by Day and Ingold[3].

V R. STIMSON

New England University,
Armidale,
New South Wales
Sept 19.

[1] Cohen and Schneider, *J Amer Chem Soc* , **63**, 3382 (1941)

[2] *Research*, **4**, 383 (1951)

[3] *Trans Farad Soc* , **37**, 686 (1941)

A General Method of Aminomethylation

EINHORN discovered that methylolamides condense with phenol (in concentrated sulphuric acid), in accordance with the equation ·

$$C_6H_5OH + R\text{CONHCH}_2\text{OH} \rightarrow C_6H_4(\text{OH})\text{CH}_2\text{NHCO}R + H_2O.$$

$$(R = \text{aryl or alkyl})$$

It has now been shown that the above reaction is a general one which can be used to introduce CH_2NH_2 groups into many aromatic compounds Thus benzene can be condensed, according to the conditions of the experiment, with one or two molecules of the methylolamide giving $C_6H_5CH_2NHCOR$ or $C_6H_4(CH_2NHCOR)_2$ These compounds are readily hydrolysed, with alcoholic hydrochloric acid, to the hydrochlorides $C_6H_5CH_2NH_2HCl$ and p-$C_6H_4(CH_2NH_2)_2 2HCl$ (and another isomer). Some methylated benzenes (toluene, the xylenes and mesitylene) have also been condensed In each case three CH_2NHCOR groups can be introduced into the molecule

Naphthalene also reacts, but the products obtained are difficultly soluble and have not yet been separated

The reaction was successful with the following mono-substituted benzenes chloro-, bromo-, iodo-, cyano-, sulphamido- In each case only one CH_2NHCOR group was introduced Nitrobenzene, benzamide and acetophenone did not react From thiophene the compounds $C_4H_3S\,CH_2NHCOR$-2 and $C_4H_2S(CH_2NHCOR)_2$ were prepared

Details of these experiments will be published elsewhere

R. Ō CINNEIDE

Department of Chemistry,
University College,
Cork.
Sept 8.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 3

British Psychological Society, Education Section (in collaboration with the Conference of Educational Associations, at University College, Gower Street, London, W C 1), at 2 30 p m —Dr Robert Logan "Healthy Youth of To-day—In the Absence of Major Disease What are the Health Needs of Youth ?"

British Museum (Natural History) (in the Huxley Lecture Theatre, Imperial College of Science and Technology, Exhibition Road, South Kensington, London, S W 7), at 5 30 p m —First of a series of twelve lectures on "The Geology and Scenery of South Africa" by Prof Frederick Walker (University of Cape Town) (Swiney Lectures on Geology) Further lectures on Mondays, Wednesdays and Fridays until January 28 *

Tuesday, January 4

Institution of Electrical Engineers, Measurements and Radio Sections (at Savoy Place, London, W C 2), at 5 30 p m —Mr H McGregor Ross "Equipment of Instrumental Accuracy for Recording and Reproduction of Electrical Signals using Cinematographic Film"

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Mr C H E Warren "Recent Advances in the Knowledge of Transonic Air Flow"

Tuesday, January 4—Friday, January 7

Geographical Association (at the London School of Economics, Houghton Street, Aldwych, London, W C 2)—Annual Conference

Wednesday, January 5

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 1 p m —Mr Robert Sergean "Communication of Information within Management Groups"

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 15 p m —Mr N T J Bailey "Some Problems in the Statistical Analysis of Epidemic Data"

Thursday, January 6

Royal Aeronautical Society (at the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S W 1), at 3 p m —Mr P G Masefield "Great Events in Aviation" (Lecture to Young People)

Royal Geographical Society (joint meeting with the Geographical Association, at 1 Kensington Gore, London, S W 7), at 3 p m —Mr F Spencer Chapman "African Journey"

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W C 2), at 5 15 p m —Mr R L Prain "The Copperbelt of Northern Rhodesia" (Henry Morley Lecture)

Institute of Metals, London Local Section (at 4 Grosvenor Gardens, London, S W 1), at 6 30 p m —Prof A H Cottrell "Some Aspects of Twinning and Kinking in Metals"

Friday, January 7

Institute of Physics, Industrial Spectroscopy Group (at 47 Belgrave Square, London, S W 1), at 4 30 p m —Dr R E Richards "The Chemical Applications of Nuclear Resonance Spectroscopy", Dr J Sheridan "Microwave Spectroscopy"

Saturday, January 8

E E G Society (at the National Hospital, Queen Square, London, W C 1), at 10 30 a m —Scientific Papers

British Mycological Society (in the Physics Lecture Theatre, Birkbeck College, Malet Street, London, W C 1), at 11 a m —Scientific Papers

British Interplanetary Society (in the York Hall of Caxton Hall, Caxton Street, Westminster, London, S W 1), at 6 p m —Mr A V Cleaver "Using Hydrogen Peroxide", Mr S Allen "Liquid Oxygen as a Rocket Propellant" *

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Engineer (with a good honours degree in mechanical engineering or equivalent professional qualifications, and preferably some experience in research), at the Central Research Establishment, National Coal Board, Isleworth, Middlesex, to carry out research on coal cutting—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/894 (January 6)

Scientific Assistant (graduate in science or agriculture, and preferably with special training in nutrition and/or a knowledge of foreign languages), for duties which will include abstracting, indexing and proof reading—The Director, Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire (January 8)

Scientist, Grade III (with an honours degree in mathematics, and preferably a qualification in statistics) on the Headquarters staff of the Pneumoconiosis Field Research (Environmental Survey) in London, for duties which will involve the analysis and correlation of statistical data collected by field investigators in the coalfields—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/895 (January 10)

Assistant Experimental Officer in the Genetics Department, to be responsible for the maintenance of genetic stocks, and to assist the Head of the Department—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (January 15)

Assistant (female) (preferably with a degree in biology or horticulture, or equivalent qualifications), for field experiments on fruit crops carried out by the Plant Pathology, Entomology and Plant Protective Chemistry Sections—The Secretary, East Malling Research Station, near Maidstone, Kent (January 15)

Mathematician (with H S C (science) or equivalent) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, to supervise operators using auxiliary punched card machines for scientific calculations and to conduct intricate card handling processes on a high-speed punched card computer—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 362/54A (January 15)

Demonstrator in the Department of Bacteriology—The Registrar, The University, Leeds 2 (January 31)

Senior Lecturer in Physiology, and a Lecturer in Physiological Chemistry, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (South Africa, January 31)

Lecturer (graduate in science or agricultural science) in Botany at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, February 1)

H Jones and Co Pineapple Research Fellow (graduate, preferably with an interest in the fields of plant pathology and/or plant physiology) to investigate problems relating to pineapple production in South Africa—The Registrar, Rhodes University, Grahamstown, South Africa (February 28)

Professor of Chemical Engineering in the University of Manchester and in the College of Technology—The Registrar, College of Technology, Manchester 1 (February 28)

Assistant (graduate in organic chemistry) in the Cancer Research Department—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middlesex

Biochemist (basic grade) (with an appropriate science degree or the A R I C , or an equivalent qualification) in the Group Laboratory—The Secretary, Royal Hospital, Chesterfield

Experimental Officer or Assistant Experimental Officer (with at least H S C in science subjects or Higher National Certificate in physics, or equivalent qualifications), to work in a section dealing with irradiation damage which will involve experimental work in connexion with research on the metal physics of existing and proposed fuels for nuclear reactors—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/210

Forestal Land, Timber and Railways Co , Ltd , Research Fellow (with at least a good honours degree in chemistry and preferably some research experience, and particular interest in applying fundamental physical chemistry and physical methods of organic chemistry to problems of industrial importance), at the Chemical Research Laboratory of the Department of Scientific and Industrial Research, Teddington, for research which will be directed to investigating the function of tannins in preventing corrosion of metals—Chief Research Chemist, Forestal Central Laboratory, Harpenden, Herts

Graduate in Physics for experimental work in solid state physics, particularly semi-conductors—The Personnel Officer, Research Laboratory, Associated Electrical Industries, Ltd , Aldermaston Court, Aldermaston, Berks

Laboratory Technician (with experience in a chemical or physical research laboratory, and preferably with some knowledge of vacuum technique), for work in the radioactive isotope laboratory—The Secretary, Barnato Joel Laboratories, Middlesex Hospital, London, W 1

Lecturer (graduate in chemistry or biochemistry and experience in the food industry, preferably in the technology of edible oils and fats or of cereals)—The Registrar, National College of Food Technology, Cranwood Street, City Road, London, E C 1

Senior Scientific Officer or Scientific Officer (with a first- or second-class honours degree in physics), and Experimental Officers or Assistant Experimental Officers (with at least H S C (science) or equivalent qualifications), for the development and operation of a mass spectrometer with emphasis on the analysis of solid materials—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/208

Editorial and Publishing Offices of " NATURE "
MACMILLAN & CO , LTD ,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £6, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd , Crown House, 143–147 Regent Street, London, W 1
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

THE FARADAY SOCIETY

A GENERAL DISCUSSION
on
MICROWAVE AND RADIO FREQUENCY SPECTROSCOPY
will be held from
April 4–6, 1955, at The University, Cambridge.

The Discussion will be divided into four main sections

- I Microwaves
- II Nuclear magnetic resonance
- III Paramagnetic resonance
- IV Quadrupole spectroscopy

Full particulars regarding application for accommodation and preprints will be issued in due course The Faraday Society, 6, Gray's Inn Square, London, W C 1

A GENERAL DISCUSSION
on
THE PHYSICAL CHEMISTRY OF ENZYMES
will be held from
August 10–12, 1955, at The University, Oxford

The Discussion, which is being arranged by the Colloid and Biophysics Committee of The Faraday Society, will be divided into two main topics

- I Kinetics and mechanisms
- II Characterisation and physical properties

Full particulars regarding application for accommodation and preprints will be issued in due course The Faraday Society, 6, Gray's Inn Square, London, W C 1

The Policy for Education

provides a means of saving for a child's education. For example, for a parent aged 35 next birthday,

The Society pays

£100 p a. for 5 years, beginning in 15 years' time,
and
if the parent dies within 15 years, £100 p a in the meantime towards the child's maintenance

The cost is

£8 7s 6d a quarter for 15 years at most

Enquire for details, giving the ages of parent and child

The Equitable Life Assurance Society

(founded 1762)

19, Coleman Street, London, E C 2

No shareholders No commission.

Postlip

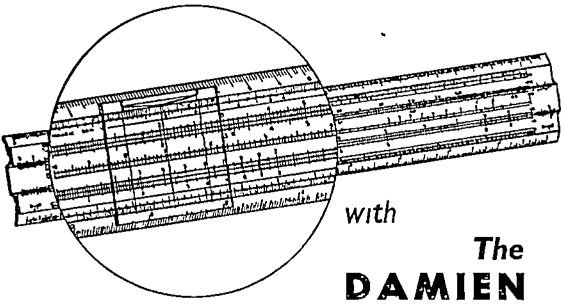
Makers of Industrial Filtering and Absorbent Base Papers

Orders and enquiries to
TECHNICAL PAPER SALES LTD.
9, Bridewell Place, London, E.C.4
Telephone : CENtral 9833

'Postlip' Papers are made by
EVANS, ADLARD & CO , LTD.

Write to ***Dept. 3N*** *for 'Postlip' samples*

SLIDE RULE EFFICIENCY



with

The

DAMIEN

METAL SLIDE RULE

Light . . unbreakable never wears out indifferent to atmospheric or other conditions Photographic printing ensures absolute accuracy, while the silver-grey finish gives figures maximum legibility. Retail price £3 3s. 0d each

SPECIAL REDUCED PRICES FOR OVERSEAS

Obtainable from leading Stationers and Drawing Office suppliers or direct from

ANODISED PRODUCTS Ltd.
91 Upper Thames Street, London, E.C.4
Telephone MAN 7765

LECTURES AND COURSES

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

A course of eight lectures
on
MICROSCOPY
will be given on

TUESDAYS and THURSDAYS at 4 p.m, commencing on TUESDAY, JANUARY 25, 1955

A course of practical work will also be given from February 21 to March 18, 1955

This will consist of eight periods of three hours each

Application for admission should be made to the Registrar of the Imperial College, Prince Consort Road, LONDON, S W 7

The fee is 2 guineas for the lectures and 4 guineas for the practical work

SWINEY LECTURES ON GEOLOGY

Under the direction of the Trustees of the
BRITISH MUSEUM (NATURAL HISTORY)

A course of twelve lectures on "The Geology and Scenery of South Africa" by Frederick Walker, Ph D D Sc, in the Huxley Lecture Theatre of the Imperial College of Science and Technology, Exhibition Road, South Kensington, S W 7, on Mondays, Wednesdays and Fridays, at 5 30 p m, from Monday, January 3 to Friday, January 28, 1955 The lectures will be illustrated

Admission free

British Museum (Natural History),
Cromwell Road London, S W 7

BOROUGH POLYTECHNIC

BOROUGH ROAD, S E 1
DEPARTMENT OF CHEMISTRY AND FOOD TECHNOLOGY

1 Surface Chemistry and Colloids Ten lectures by Dr K G Pankhurst Wednesdays from January 19, 1955 7 30 to 9 p m 2 Surface Active Agents—Organic Chemistry and Analysis Ten lectures by a panel of specialists Wednesdays from January 19, 1955 6 to 7 15 p m

For further details apply to the Borough Polytechnic, Borough Road, London, S E 1

BOROUGH POLYTECHNIC

BOROUGH ROAD S E 1
DEPARTMENT OF CHEMISTRY AND FOOD TECHNOLOGY
HUMAN NUTRITION—ENERGY REQUIREMENTS

A course of ten lectures by Dr O G Edholme, Dr J M Hunt, Dr H E Magee, Dr W J Berry, on Mondays, 6 30 to 8 30 p m, January 17 to March 11, 1955

For further details apply to Borough Polytechnic, Borough Road, London, S E 1

BIRKBECK COLLEGE

(UNIVERSITY OF LONDON)
SESSION 1955-1956 BEGINS MONDAY, OCTOBER 3, 1955

Part-time (Evening) Courses provided for Internal Degrees in the Faculties of Arts and Science and for the Academic Postgraduate Diploma in Psychology Facilities also provided for part-time and full-time students reading for higher degrees in arts and science Applications for admission should be made before June 1

Pamphlet and form of application may be obtained from the Registrar, Birkbeck College, Malet Street W C 1

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive or a woman aged* 18 *to* 59 *inclusive unless he or she, or the employment is excepted from the provisions of the Notification of Vacancies Order,* 1952

UNIVERSITY OF ABERDEEN

Applications invited for a Research Scholarship in the Department of Chemistry for three years on problems connected with aluminates The research may be submitted for the degree of Doctor of Philosophy The annual value of the scholarship will be between £300 and £600 depending on experience and qualifications, in addition to university fees

Applications, giving full details of qualifications and experience, and the names of two referees, to be submitted to the Secretary, University of Aberdeen, by January 31, 1955

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

Applications are invited for a number of appointments as Research Officer or Senior Research Officer, in the Coal Research Section, Sydney, New South Wales Details of the positions are set out below Position No 480/150 Duties To undertake investigations of the chemical structure of Australian coals and assessment of their potential value to the chemical industry and in particular, to examine the behaviour of coals in various chemical reactions such as hydrogenolysis or to study the chemical reactions occurring during the pyrolysis of coals Qualifications University honours degree in science, with chemistry as major subject and physics to a high standard Experience in the chemistry of natural or polymeric substances would be an advantage Position No 480/153 Duties To participate in the activities of a group concerned with the studying of the mechanical properties of coal and their industrial significance This work involves a fundamental study of coal strength and breaking processes Qualifications University honours degree in science, with physics or mathematics as major subjects or engineering Additional postgraduate research experience would be an advantage Position No 480/154 Duties To participate in studies being undertaken to evaluate combustion characteristics of Australian coals The group concerned is undertaking fundamental studies of combustion processes, clinkering phenomena, and the burning of coal in suspension and in model fuel beds Qualifications University honours degree in science or fuel tech nology Further postgraduate research experience would be an advantage Salary Dependent on qualifications and experience, commencing salary will be determined within the range of Senior Research Officer, £A 1,274 to £A 1,552 per annum nominal (£A 1,472 to £A 1,750 per annum actual), £30 increments, subject to efficiency review at £A 1 366 per annum nominal, Research Officer £A 860 to £A 1,214 per annum nominal (£A 1,058 to £A 1,412 per annum actual), thirteen increments, subject to efficiency review at £A 908 and £A 1,064 per annum nominal Note The above salaries apply to a male appointee, actual salaries include cost of living adjustment which at present increases male nominal salaries by £A 198 per annum The appointment will be conditional on a satisfactory medical examination and the successful applicant will be eligible to contribute to and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Account

Applications, referring to the appropriate appointment number, and stating full name, place date and year of birth, marital state, nationality present employment, particulars of qualifications and experience, and of war service if any, accompanied by copies of not more than four testimonials, should reach the undersigned by January 29, 1955

W IVES,
Chief Scientific Liaison Officer
Australian Scientific Liaison Office,
Africa House,
Kingsway, London W C 2

NATIONAL RESEARCH COUNCIL

CANADA
DIVISION OF BUILDING RESEARCH
SNOW AND ICE RESEARCH

Applications are invited from physics or engineering physics graduates with a Ph D or Masters degree, to work in the Snow and Ice Research Field New and modern laboratory facilities are available Salary commensurate with qualifications This opening provides a challenging opportunity in a new and important field

Applications, listing full details of education and experience, should be sent to the Employment Officer, National Research Council, Ottawa 2 Canada Please refer to File BR-96 Applicants in England may obtain information on the National Research Council and the Division of Building Research from a Canadian Scientific Liaison Officer Africa House, Kingsway London W C 2 England

UNIVERSITY OF LONDON

Applications are invited for I C I Research Fellowships in Biochemistry, Chemistry Chemotherapy, Engineering, Metallurgy, Pharmacology Physics or allied subjects, tenable from October 1, 1955 normally for three years in the first instance Salary not less than £750 per annum, with family allowances and F S S U

Information and application forms can be obtained from the Academic Registrar, University of London, Senate House, W C 1 Applications must be received not later than April 16, 1955

COMMONWEALTH SCIENTI
AND INDUSTRIAL RESEAR
ORGANIZATION

WOOL TEXTILE RESEARCH
LABORATORIES, BIOCHEMISTRY U
APPOINTMENT NO 462/76 OF CHE

Applications are invited for appointment
position of Research Officer (Chemist) Loc
Initially in the Department of Organic Che
University of Melbourne Duties To d
specific reagents for the chemical modificat
proteins and to study the effect of such re
on the chemical and physical properties o
keratin This investigation would form p
a comprehensive study on proteins being
taken at Biochemistry Unit of the Wool
Research Laboratories in Melbourne Qu
tions University honours degree in che
preferably with research experience in th
of organic chemistry Salary Depende
qualifications and experience, commencing
will be determined within the range of R
Officer, £A 860 to £A 1,214 per annum n
(£A 1,058 to £A 1,412 per annum actual), t
increments, subject to efficiency review at
and £A 1,064 per annum nominal Note
above salaries apply to a male appointee,
salaries include cost of living adjustment
at present increases male nominal salar
£A 198 per annum The appointment will b
ditional on a satisfactory medical examinat
the successful applicant will be eligible t
tribute to, and receive benefits from, eith
Commonwealth Superannuation Fund or the
monwealth Provident Account

Applications, referring to Appointment
462/76 and stating full name place, date an
of birth, marital state, nationality, presen
ployment, particulars of qualifications and
ence, and of war service, if any, accompan
copies of not more than four testimonials,
reach the undersigned not later than Janua
1955

W IV
Chief Scientific Liaison
Australian Scientific Liaison Office,
Africa House,
Kingsway, London, W C 2

H M OVERSEA CIVIL SERVI

Applications are invited for the following
Chemist, Agricultural Department, Sierra
to make a soil survey of part of the No
Province of Sierra Leone, with particular
ence to the nutrient status and fertilizer re
ments of soils suitable for mechanized rice c
tion Candidates must hold a degree in n
science and preferably have had postgra
experience, particularly in soil survey work
pointment on contract for a tour of 18
months in the first instance in the salary
£616 to £1 408 per annum, plus an expatr
allowance of £182 to £350 per annum A g
of £25 to £37 10s for each completed three-
period of satisfactory service is payable o
mination of contract Outfit allowance o
on first appointment Free passages for
wife and up to two children under the a
10 Government quarters when available,
rental of up to 10 per cent of salary (max
£150 per annum)

Apply in writing to the Director of R
ment, Colonial Office Great Smith Street,
don S W 1, giving briefly age qualification
experience Mention the reference number
63/15/04

H M OVERSEA CIVIL SERVI

Applications are invited for the following
Agricultural Education Officer Basutoland
take administrative and academic charge
new training centre for subordinate staff o
Agricultural Department Candidates shou
about 35 years of age and have a univ
degree in agriculture with experience of tea
Appointment on contract for three years i
salary scale £585 to £1,230 per annum, p
cost-of-living allowance of between ap
mately £111 and £212 a year for a married
and approximately £56 and £106 for a
officer Education allowance of £40 per a
for each of up to three children under 18
of age who attend school outside Basut
Gratuity of between £15 and £37 10s for
completed three months' period of satisf
service Free passages for officer, wife an
to three children Government quarters,
available, at rental of 10 per cent of sala

Apply in writing, to the Director of Re
ment, Colonial Office, Great Smith Street,
don, S W 1, giving briefly age qualifications
experience Mention the reference nu
BCD 63/76/07

OMMONWEALTH SCIENTIFIC
ND INDUSTRIAL RESEARCH ORGANIZATION
ISION OF FOOD PRESERVATION AND TRANSPORT
POINTMENT NO 300/151 OF ORGANIC CHEMIST

plications are invited for appointment to a
ion of Research Officer, Organic Chemist,
ebush, N S W Duties Investigations, with
iall group of chemists, on chemical reactions
rring in processed foodstuffs during storage
on the chemical composition of the natural
ucts, the work will initially relate to fruit
vegetables Qualifications University
urs degree in science with organic chemistry
major subject and some postgraduate re-
h experience in that subject Salary De-
ent on qualifications and experience, com-
ing salary will be determined within the
of Research Officer, £A 860 to £A 1,214 per
m nominal (£A 1,058 to £A 1 412 per annum
l) thirteen increments, subject to efficiency
w at £A 908 and £A 1,064 per annum nominal

The above salaries apply to a male ap-
ee, actual salaries include cost of living
stment which at present increases male
nal salaries by £A 198 per annum The ap-
ment will be conditional on a satisfactory
al examination and the successful applicant
be eligible to contribute to, and receive
fits from, either the Commonwealth Super-
ation Fund or the Commonwealth Provident
unt

plications, referring to Appointment Number
151, and stating full name, place, date and
of birth, marital state, nationality, present
oyment, particulars of qualifications and ex
nce, and of war service, if any, accompanied
copies of not more than four testimonials
ld reach the undersigned by January 29, 1955

W IVES,
Chief Scientific Liaison Officer

ralian Scientific Liaison Office,
rica House,
Kingsway, London, W C 2

UNIVERSITY OF LEEDS
DEPARTMENT OF BOTANY

plications are invited from candidates with
al interests in genetics or genecology, for ap-
ment as Lecturer or Assistant Lecturer in
ny, the salary scales are at present under
w

plications (three copies) stating date of birth,
fications and experience, together with the
s of three referees, should reach the Regis-
The University, Leeds, 2 (from whom further
ulars may be obtained), not later than
iary 19, 1955

OTTISH HOME DEPARTMENT, MARINE
ratory, Aberdeen Assistant Experimental
r or Experimental Officer Applications are
d for two posts, unpensionable in the first
which are concerned with (1) research on
fficiency of fishing gear and (2) statistics
only may apply for the first post, men and
n may apply for the other Age 18 but
31 on December 31, 1955 Qualifications
sh leaving certificate, higher school certifi-
general certificate of education, university
e, graduate membership of a professional in-
on, the higher national certificate, final
cate of the City and Guilds of London Insti-
or equivalent Candidates without such
ications may be considered if evidence of
le experience on scientific research and de-
nent work can be produced, but those aged
d above will generally be expected to have
s degree or a technical qualification The
of post (1) will be concerned with research
e efficiency of fishing and research gear and
ising new types or modifications of gear to
se efficiency, preference being given to can-
s with some knowledge of light engineering
and development work and capable of
hop supervision in addition to keeping in
with contract work, post (2) routine com-
and compilation of statistics with the ex-
ion of taking charge of a small computing
it the laboratory Men will be required to
take periods of duty at sea Inclusive
s for Assistant Experimental Officers
10s to £640 (men), £288 10s to £540
en), starting salaries according to age with
ium of £512 10s (men), £482 10s (women)
ive salaries for Experimental Officers £715
80 (men), £620 to £757 (women) starting at
inimum —Particulars and application form
Establishment Officer, Scottish Home De-
ent, Room 364, St Andrew's House Edin-
1 Applications to be returned by January
55

UNIVERSITY OF OXFORD
THE QUEEN'S COLLEGE
RESEARCH FELLOWSHIP

The Governing Body proposes, if a suitable candidate presents himself, to elect early during the Long Vacation to a Junior Research Fellowship in one of the following subjects Mathematics, Physical Sciences, English The successful candidate will enter upon his fellowship on Oc ober 1 The fellowship is of the value of £450 per annum, and is pensionable under the Federated Superannuation Scheme for Universities It will be tenable for three years and may (but only in exceptional circumstances) be renewed for a further period not exceeding three years The fellow will be entitled to free rooms in college and free dinner at the Common Table He may, with the leave of the Governing Body, engage in teaching up to a maximum of six hours weekly Candidates must by that date have passed with honours all the examinations required for a first degree at a university within the United Kingdom, and must not have entered upon the thirty-first term for their matriculation

Candidates should apply to the Provost, The Queen's College, not later than April 16, 1955 They should enclose a statement of their qualifications and of the nature of advanced study or research they propose to undertake They should also give the names of not more than three persons prepared to act as referees Candidates are invited to submit in evidence either published work or a copy of work in progress (e g the whole or part of an unpublished thesis) Candidates not submitting such work will be set a General Paper to be taken at the College on May 13 (and this paper may be taken by other candidates if they so desire)

McMASTER UNIVERSITY
DEPARTMENT OF CHEMISTRY
GRADUATE ASSISTANTSHIPS

Applications are invited for part-time teaching and Research Assistantships from persons qualified to register in courses leading to the M Sc and Ph D degrees in chemistry Assistantships normally carry a yearly stipend of $1,400 to $1,600 Assistants are required to devote eight to ten hours per week to duties during the academic session (October to April inclusive) and may devote full time to their research during the summer Research is in progress in the following fields mass spectrometry, nuclear chemistry radiochemistry natural isotopic abundance ratios and their biological and geological significance, isotope effects, organic reaction mechanisms, physical chemistry of high-polymer solutions, isolation and structure of plant alkaloids biogenesis of the thyroid hormone, intermediary metabolism inorganic analytical methods

Interested persons should write to Dr R P Graham Chairman of the Department of Chemistry, Hamilton College, McMaster University Hamilton, Ontario Canada

---

UNIVERSITY OF LONDON

Applications are invited for Turner and Newall Research Fellowships in Engineering, Inorganic Chemistry, Physics or an allied subject, tenable from October 1 1955, normally for three years in the first instance Salary not less than £750 per annum with family allowances and F S S U

Information and application forms can be obtained from the Academic Registrar University of London, Senate House W C 1 Applications must be received not later than April 16, 1955

MECHANICAL ENGINEERS REQUIRED by Ministry of Supply at Armament Research and Development Establishment near Sevenoaks, Kent, Fighting Vehicles Research and Development Establishment near Chertsey, Surrey, National Gas Turbine Establishment near Farnborough Hants, Aeroplane and Armament Establishment, Amesbury, Wilts, Royal Aircraft Establishment Farnborough, Hants and outstations Work concerned with research design and development of a wide range of civil and military equipment including aircraft, armaments, fighting vehicles, gas turbines, guided weapons, rockets and accessories Appointments according to qualifications age and experience connected with appropriate research or development Scientific Officers (first- or second-class honours graduates) Salary £445 to £815, Experimental Officers and Assistant Experimental Officers (higher school certificate (science) or equivalent degree or H N C may be an advantage) Salary Experimental Officers (minimum age 26) £690 to £850, Assistant Experimental Officers £276 (age 18) to £615 Women somewhat less F S S U benefits may be available for Scientific Officer class —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K) 26 King Street, London S W 1, quoting C 805/54A

ROTHAMSTED EXPERIMENTAL STATION
HARPENDEN, HERTS

Chemist required in the Department of Insecticides and Fungicides for general analytical work and assisting in developing analytical methods for determining insecticides in soil and in plant materials Experience of analytical work in any field would be an advantage The appointment will be in the Experimental Officer class, with starting salary for graduates between £390 and £690 per annum, according to age and experience Scales for women are somewhat lower Superannuation scheme

Applications, quoting reference 105, with names of two referees, to be addressed to the Secretary

---

UNIVERSITY OF ADELAIDE
WAITE AGRICULTURAL RESEARCH INSTITUTE
SOUTH AUSTRALIA

Applications are invited for the position of Entomologist in the Department of Entomology of the Waite Institute Duties To assist as required in the work of the Department this may include some teaching or advisory work The appointee will be able to devote most of his time to research, and will be expected to develop a programme in some appropriate field, preference will be given in the present appointment to a worker in experimental ecology or insect physiology Status The appointment carries the status of a Lecturer in the University, applicants are invited to seek from the undersigned copies of the detailed conditions of appointment of lecturers to the University Salary Scale £A 1,000 by £A 60 to £A 1,360 Superannuation On F S S U basis Travelling Allowance See detailed conditions of appointment of lecturers Applications An application must include particulars of age, nationality, academic record, experience, war service (if any) and present position, a list of publications, copies of testimonials, the names and addresses of two referees from whom inquiries may be made, a recent photograph, and a medical certificate of good health It should be lodged with the undersigned not later than January 31, 1955

Further information about the post or about the University and the Waite Institute will be supplied on request

A W BAMPTON,
Registrar

The University of Adelaide,
Adelaide, South Australia

UNIVERSITY OF TORONTO
DEPARTMENT OF PHYSICS
TORONTO 5, CANADA

A vacancy exists for an Assistant Professor in the Department of Physics, with special interest in low temperature research

For conditions of appointment write to Professor W H Watson, giving details of academic training and experience

---

UNITED KINGDOM ATOMIC ENERGY Authority, A E R E, Harwell, Berks requires staff to work on the operation and maintenance of an electronic digital computer Successful candidates will first of all have a period of service at A E R E, Harwell, to receive training in computer electronic work, but will be required to transfer to A W R E, Aldermaston, Berks, at a later date Experience of servicing and testing electronic equipment would be an advantage Appointments, according to age, experience and qualifications will either be in the grades of Senior Experimental Officer (£1 017 to £1,197 per annum), Experimental Officer (£715 (minimum age 26) to £880 per annum), Assistant Experimental Officer (£288 (at age 18) to £640 per annum), or Senior Scientific Assistant (£545 (minimum age 27) to £745 per annum) or Scientific Assistant (£217 (at age 16) to £474 per annum) Rates for women are slightly lower Minimum qualifications for Experimental Officer grades are higher school certificate or general certificate of education (advanced) in science subjects, preferably physics and mathematics or equivalent qualifications, for Scientific Assistant grades ordinary national certificate or general certificate of education (ordinary) in science subjects preferably physics and mathematics, or City and Guilds Certificates in radio and telecommunications third year, or equivalent qualifications Exceptionally, unqualified candidates with wide experience in the field will be considered The successful candidates will later be required to join the Authority's contributory pension scheme, and the salaries quoted above will be increased to cover personal contributions —Applications to Establishment Officer, A E R E, Harwell, Didcot Berks, quoting reference 2/103/206

TEA RESEARCH INSTITUTE OF EAST AFRICA

P O BOX 91 KERICHO, KENYA COLONY

Applications are invited for the post of Assistant in the Agricultural Section Applicants should possess a degree from a recognized university, in agriculture (or equivalent qualification), and preferably at least two years' postgraduate experience A good knowledge of statistical methods as applied to field experiments is desirable Applicants who have not completed their two years National Service, or have no comparable war service, will not be considered Salary scale £700 by £75 to £1,750 per annum A starting salary above the minimum (up to four increments) may be offered to a candidate with suitable experience Free quarters with heavy furniture, or an allowance in lieu thereof, will be provided Membership of the Institute's Provident Fund is compulsory, members and the Institute each contribute to the fund the equivalent of 10 per cent salary Overseas leave is at two months per year of completed service, normally at intervals of three years, subject to the exigencies of the Institute's work, three weeks' local leave per year Free passages on appointment and on overseas leave for self, wife and children under 15 years

Applications, by airmail giving the names of two professional and one personal referee, should be addressed to the Director (from whom further particulars can be obtained) to arrive not later than February 28, 1955

UNIVERSITY OF SYDNEY

AUSTRALIA

Applications are invited for the position of Lecturer/Senior Lecturer in Botany Other things being equal, preference will be given to applicants interested in undertaking genecological or cytogenetic studies on the Australian flora The salary for a Lecturer is within the range of £A 1,100 to £A 1,450 per annum, for a Senior Lecturer £A 1 500 to £A 1 750 per annum, with annual increments of £A 50 The salary is subject to deductions under the State Superannuation Act The commencing salary will be fixed according to the qualifications and experience of the successful applicant Finance available for home purchase under Staff Members' Housing Scheme

Further particulars and information as to the method of application should be obtained from the Secretary Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 The closing date for the receipt of applications in Australia and London is January 19, 1955

ELECTRICAL RESEARCH ASSOCIATION

Technical Assistant required for research on applications of electricity in horticulture Qualifications expected are a good degree in electrical engineering or physics, with some knowledge of electronics Research experience an advantage Starting salary will be in the range of £500 to £600 per annum with superannuation provisions

Applications should be addressed to the Director, E R A Field Station, Shinfield Green, near Reading, to arrive not later than January 10, 1955

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

Research Assistant required by the above Association to assist in experimental work connected with the chemistry of steelmaking, and to carry out analysis of metals and slags Previous experience in metallurgical analysis desirable Age 20 to 25 Starting salary in the range £400 to £500 per annum, according to age, qualifications and experience Location of work London (Battersea) Staff pension scheme

Written applications only, quoting "Analysis," to Personnel Officer, B I S R A, 11 Park Lane, London W 1

SOUTH-EASTERN GAS BOARD, CENTRAL Laboratories 709 Old Kent Road, London, S E 15 Vacancies exist for Junior Assistant Chemists Applicants should possess a B Sc degree or its equivalent, some experience in fuel technology, though not essential would be of advantage Salary £530 to £640 per annum, depending on qualifications and experience Librarian (female) Applicants for this post should possess a science degree and a good working knowledge of French and German so as to be capable of freely translating original scientific papers in these languages Salary £424 to £512 per annum—Applications in writing giving full details to Personnel Manager Katharine Street, Croydon, quoting reference V28/488

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

A E R E, HARWELL, BERKS

Requires a Senior Scientific Officer or Scientific Officer and Experimental Officers or Assistant Experimental Officers for the development and operation of a mass spectrometer, with emphasis on the analysis of solid materials Candidates should have had experience in electronics and vacuum techniques Experience in mass spectrometry would be an advantage Qualifications for Scientific Officer class are first- or second-class honours degree in physics, and appointment, according to age, experience and qualifications will either be in the grade of Senior Scientific Officer (£970 to £1 125 per annum) or Scientific Officer (£467 to £845 per annum) Minimum qualifications for Experimental Officer class are higher school certificate in science subjects, or equivalent qualifications, but a candidate with a physics degree or equivalent would be preferred, and appointment, according to age, experience and qualifications, will either be in the grade of Experimental Officer (£715 (minimum age 26) to £880 per annum) or Assistant Experimental Officer (£288 (at age 18) to £640 per annum) Rates for women are slightly lower The successful candidates will be required to join the Authority's contributory superannuation scheme, which is to be introduced in the near future, and salaries will be increased to cover personal contributions

Applications should be sent to Establishment Officer, A E R E Harwell, Didcot, Berks, quoting reference 2/103/208

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG, SOUTH AFRICA

Applications are invited for appointment to the following vacant posts on the staff of the University Department of Physiology (a) One Senior Lectureship in Physiology, (b) One Lectureship in Physiological Chemistry The Senior Lectureship will be in physiology and the appointment calls for a knowledge of human and experimental physiology, experience in research and although not essential, a medical qualification will be an additional recommendation In the case of the Lectureship in Physiological Chemistry, the successful applicant will be required to be a graduate in chemistry, or the equivalent thereof, and to participate in the teaching of physiological chemistry The salary scales attached to the posts are Senior Lecturer £1 100 by £50 to £1,450, Lecturer, £850 by £50 to £1,150 The initial salary to be paid to the successful applicants will be determined in accordance with qualifications and experience In addition, a temporary cost of living allowance is paid to married men, the present rate being £234 per annum Duties to be assumed on April 1, 1955, or as soon as possible thereafter An allowance is made towards the cost of travelling expenses

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 The closing date for the receipt of applications, in South Africa and London, is January 31, 1955

HANNAH DAIRY RESEARCH INSTITUTE

Applications are invited from men with a degree in chemistry or physics or the N D D T for a post in the Technical Chemistry Department of the Hannah Dairy Research Institute for work on the manufacture and analysis of milk powders and evaporated milk Salary Assistant Experimental Officers, £330 (at age 20) to £615, Experimental Officers, £690 to £850, according to age and experience (Superannuation)

Applications, with names of two referees to be sent within two weeks to the Secretary Kirkhill, Ayr, from whom further particulars may be obtained

---

EAST MALLING RESEARCH STATION

A vacancy for an Assistant, female, for field experiments on fruit crops carried out by the Plant Pathology Entomology and Plant Protective Chemistry Sections Salary according to age in the Assistant Experimental Officer grade of the Ministry of Agriculture scale A degree in biology or horticulture, or equivalent, is preferred

Application forms and details from the Secretary East Malling Research Station, near Maidstone Kent by whom applications should be received not later than January 15 1955

UNIVERSITY OF SYDNEY

Applications are invited for five Res
Studentships/Fellowships in the School of Ph
The successful applicants will be appointed
cording to qualifications and experience,
Research Studentship (£A 750 to £A 850 pe
num), to a Junior Research Fellowship (£
per annum) or to a Senior Research Fello
(£A 950 to £A 1,300 per annum) Fares to
from Australia, not exceeding a total of £A
may be paid The awards will normally be
for a period of two years, after which
tenure may be renewed for a further period
doctoral candidates will normally be awarde
search Studentships, and will be expected to
the Physics IV examination at honours B Sc
before proceeding to work for the Ph D d
Study for this examination may take up pa
all of the first year in Sydney Experim
work in the School of Physics is directe
Dr E P George, and nuclear research emul
cloud chambers and counters are used in e
ments covering many aspects of cosmic ra
search Theoretical research is under the
tion of Professor H Messel, and investiga
into problems of nuclear atomic and solid
physics are in progress A large high-speed d
computer is under construction

Applications, giving full details of qualific
and experience and the names of referees, s
be forwarded to reach the Registrar, Univer
Sydney Sydney, Australia, by February 28
In addition a copy of the application s
be forwarded to the Secretary of the Assoc
of Universities of the British Commonweal
Gordon Square, London, W C 1, by the
date

UNIVERSITY OF READING

The Council invites applications for a Le
ship in Theoretical Physics The present
scale, which is under review is £900 per an
rising by annual increments of £50 to £1,10
annum Candidates should possess sufficie
perience and standing to enable them, in ad
to lecturing to carry out independent res
and to supervise the work of postgra
students

Further particulars may be obtained fro
Registrar, The University, Reading, by who
plications should be received not later than
ary 17, 1955

HILL END HOSPITAL

ST ALBANS HERTS

Biochemist (non-medical), University Grad
required for duties in the Pathological Depar
at the above hospital The successful cand
should have had at least two years' expe
in a hospital laboratory, but consideration
be given to recently qualified candidates I
consist of routine and more advanced bioche
techniques and research experience will b
advantage Salary and conditions of servic
cording to Whitley Council

Applications to the Consultant Pathologis

LONDON TRANSPORT INVITE APP
tions from graduates, first- or second-class ho
degrees in physics, for post in Central La
tory Chiswick Duties physical testing a
vestigation of wide range of items, includi
cumulators, electric lamps, plastics, rubber
insulating materials, safety glass, etc, co
tion, maintenance and calibration of appa
development of non-destructive tests based
ultrasonic, magnetic and electrical technique
vestigations of physical problems arising
London Transport Salary £520 to £800
Commencing salary according to age, qua
tions and experience Medical exam Con
tory superannuation scheme after probation
plications to Staff Officer (F/EV 502) L
Transport, 55 Broadway, S W 1 For ackno
ment enclose addressed envelope

A RESEARCH FELLOWSHIP OF £750
annum, renewable annually for a period of
years and tenable at the Chemical Re
Laboratory of the Department of Scientific
Industrial Research Teddington is offered
Forestal Land Timber & Railways Co Ltd
research will be directed to investigating the
tion of tannins in preventing corrosion of n
and the results could be made available
higher degree Applicants should have
minimum qualification a good honours deg
chemistry and preferably some research e
ence They should have a particular inter
applying fundamental physical chemistry and
sical methods of organic chemistry to pro
of industrial importance—Applications
references, should be sent to the Chief Re
Chemist, Forestal Central Laboratory, Harp
Herts

EMORIAL UNIVERSITY OF NEWFOUNDLAND

JOHN'S, NEWFOUNDLAND, CANADA

Memorial University of Newfoundland in-
applications from qualified persons to fill
acant position of

SSOCIATE PROFESSOR OF PHYSICS

duties of the successful applicant will be to
in courses of instruction leading to the
es of B A , B Sc , and M Sc These duties
normally such that the appointee will have
available to carry on his own research prob-
The salary scale for Associate Professor
doctorate or equivalent is $5,000 by $100 to
0 A comprehensive contributory pension
ne applies The appointment will take effect
eptember, 1955, and is provisional for two
Travel expenses incurred in taking up the
intment are payable by the university to a
mum of $750

plications should be sent to the President,
g a complete curriculum vitae and the names
addresses of three referees

UNIVERSITY OF DURHAM

plications are invited for the post of Pro-
r of Physics in the Durham Colleges in the
ersity of Durham Salary within the ap-
ed professorial scale with normal starting
at £1,900 per annum, with family allow-
s and F S S U

rther particulars may be obtained from the
rsigned with whom fifteen copies of applica-
containing names of three persons to whom
ence may be made should be lodged not later
February 12, 1955 Candidates outside the
ish Isles may submit one copy only

E M BETTENSON,
Registrar

versity Office,
North Bailey, Durham

UNIVERSITY OF DURHAM

pplications are invited for the post of Pro-
or of Physics in the Newcastle Division of the
versity of Durham Salary within the ap-
ved professorial scale with normal starting
at £1 900 per annum, with family allowances
F S S U

urther particulars may be obtained from the
ersigned with whom fifteen copies of applica-
s containing names of three persons to whom
ence may be made should be lodged not later
February 12, 1955 Candidates outside the
ish Isles may submit one copy only

E M BETTENSON,
Registrar

versity Office
North Bailey Durham

UNIVERSITY OF ABERDEEN

enior Technician required for Physiology De-
ment, Marischal College Wage on scale £460
£20 to £560 placing according to qualifica-
and experience

pplications in writing to the Secretary, Mari-
l College

EPARTMENT OF SCIENTIFIC AND IN-
rial Research require an Experimental Officer
Assistant Experimental Officer (unestablished)
the Food Investigation Headquarters Cam-
ge, for editorial duties on a journal of scien-
and technical abstracts and reviews on food
nce and technology Candidates must have
E advanced level in two science subjects
equivalent , but over 22 will generally be ex-
ted to have a pass degree in science or equi-
nt Ability to write clear and concise English
ntial Some knowledge of European langu-
an advantage The successful candidate will
given the necessary training Only candidates
26 will be considered for Experimental Officer
le Inclusive annual remuneration for a 45½-
r week (a) for Experimental Officer, £736 to
6 (men) £638 to £779 (women) , (b) for Assis-
Experimental Officer, £297 to £659 (men),
7 to £556 (women) Prospects of establish-
t for candidates under 31 —Application forms
Ministry of Labour and National Service,
hnical and Scientific Register (K) 26 King
et London S W 1, quoting G 444/54A
sing date January 22, 1955

IOCHEMIST (BASIC GRADE) REQUIRED
work in the Biochemistry Section of the Patho-
Department Salary and conditions in ac-
lance with P T A scales—i e , £460 to £765
annum according to qualifications and ex-
ience —Applications, in writing giving names
three referees, to the Superintendent, The
ted Sheffield Hospitals The Children's Hos-
l Western Bank, Sheffield 10

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

requires

MATHEMATICAL PHYSICISTS

in the grades of PRINCIPAL SCIENTIFIC OFFICER, SENIOR SCIENTIFIC OFFICER and SCIENTIFIC OFFICER, to be engaged on work in one of the following fields —

1 Astrophysics
2 Fluid Dynamics
3 Nuclear Physics
4 Statistics
5 Solid Mechanics
6 General Applied Mechanics

Applicants should have a first- or second-class honours degree in MATHEMATICS or PHYSICS, together with some years' appropriate postgraduate experience The salary scales are PRINCIPAL SCIENTIFIC OFFICER, £1,125 to £1,507 (male) per annum , SENIOR SCIENTIFIC OFFICER £970 to £1,125 (male) per annum , for SCIENTIFIC OFFICER, £467 10s to £845 (male) per annum , for which starting salary is assessed, according to age, qualifications and experience The successful applicants will be required to join the Authority's Principal Superannuation Scheme to be introduced shortly, and the salary scales quoted will be enhanced to cover contributions Houses available within a reasonable period for married staff who live outside the Establishment's transport facilities Application form from Senior Recruitment Officer, A W R E , Aldermaston, Berks Quote Reference 283/WGE/34

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE BRADFORD

Applications are invited for appointment as Senior Lecturer in Mechanical Engineering in the College Candidates should be able to offer applied thermodynamics The salary scale for men (according to the Burnham Technical Award) will be from £1,065 to £1,215 per annum

Conditions of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, 1, and completed forms should be returned to the Principal of the College as soon as possible

A SPALDING,
Director of Education

COLLEGE OF AERONAUTICS

Lecturer required in Department of Aerodynamics, with experience in wind tunnel research work Successful candidate will be required to supervise students' experimental and theoretical research in addition to his lecturing duties He will also be expected to play a leading part in the expanding experimental research programme of the department Salary in accordance with qualifications and experience, with superannuation under F S S U and family allowance

Applications giving full details of qualifications, etc , and quoting the names of three referees, should be addressed to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks Further particulars available

---

LONDON TRANSPORT REQUIRES TECHnical Assistants, Central Laboratory, Chiswick Candidates should possess Inter B Sc or equivalent qualification Previous experience advantageous Salary range £300 to £625, with additional payments for certain recognized qualifications Commencing salary according to age, qualifications and experience medical examination , contributory superannuation scheme after probation , certain free travel facilities —Applications to Staff Officer (F/EV 519), London Transport, 55 Broadway, S W 1 For acknowledgment enclose addressed envelope

---

APPLICATIONS ARE INVITED FROM Technicians with a sound knowledge of routine haematology procedures, to fill a vacancy in the undermentioned laboratory The post is established on the Technician Grade, but applicants holding the Institute of Medical Laboratory's Intermediate Certificate will be considered The salary and conditions of service will be as defined by the appropriate Whitley Council —Applications, giving full details, and the names of two referees, should be made to the Secretary, The Laboratory, Peace Memorial Hospital, Watford, Herts

---

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

A E R E , HARWELL, BERKS

Requires an Experimental Officer or Assistant Experimental Officer, to work in a section dealing with irradiation damage which will involve experimental work in connection with research on the metal physics of existing and proposed fuels for nuclear reactors Ample opportunities will exist for original experimental work Minimum qualifications required are higher school certificate in science subjects or higher national certificate in physics, or equivalent qualifications A degree in physics would be an advantage Successful candidate will be appointed either in the grade of Experimental Officer (£715 (minimum age 26) to £880 per annum), or Assistant Experimental Officer (£288 (at age 18) to £640 per annum), according to age, experience and qualifications He will be required to join the Authority's contributory pension scheme, which is to be introduced in the near future and salaries will be increased to cover personal contributions Rates for women are slightly lower

Applications should be sent to Establishment Officer, A E R E Harwell, Didcot, Berks, quoting reference 2/103/210

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG SOUTH AFRICA

Applications are invited for appointment to the vacant post of Senior Lecturer in Zoology on the staff of the University Department of Zoology The substantive salary scale attached to the post is £1,100 by £50 to £1,450 The initial salary to be paid to the successful applicant will be determined in accordance with qualifications and experience In addition, a temporary cost of living allowance is paid to married men, the present rate being £234 per annum Duties to be assumed on March 1, 1955, or as agreed upon with the successful candidate An allowance is made towards the cost of travelling expenses

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 The closing date for the receipt of applications, in South Africa and London, is January 31, 1955

ROTHAMSTED EXPERIMENTAL STATION

HARPENDEN, HERTS

Applications are invited from graduates for a post in the Department of Insecticides and Fungicides, to assist in the study of the mode of action of insecticides Candidates should have a knowledge of organic chemistry or biochemistry , previous experience in the field of insecticides is not necessary The appointment will be in the Experimental Officer class with starting salary for graduates between £390 and £690 per annum, according to age and experience Scales for women are somewhat lower Superannuation scheme

Applications, quoting reference 105(2) with names of two referees to be received by the Secretary by January 22, 1955

UNIVERSITY OF NATAL

SOUTH AFRICA

Applications are invited for the post of Director of the Institute for Social Research at the University of Natal, Durban The appointment will be for the two academic years 1955 and 1956 Duties to commence on March 1, 1955, or as soon thereafter as possible Salary £1,600 per annum, plus a temporary cost of living allowance of £234 per annum for married men

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth 5 Gordon Square, London, W C 1 The closing date for the receipt of applications in South Africa and London, is January 31, 1955

RESEARCH LABORATORIES, BRITISH Electricity Authority, Leatherhead, require two General Assistant Engineers Candidates should have a university degree or equivalent qualifications in electrical engineering or in physics Duties include research on electrostatic precipitation and allied problems at Leatherhead and Croydon Laboratories Salary N J B Grade 4, £675 to £850 per annum —Applications, stating age, qualifications, experience, and present position and salary, should be forwarded to D Moffat, Director of Establishments, Winsley Street London W 1, by January 17, 1955 Quote reference NAT /541

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston, Berks, requires Experimental Officers and Assistant Experimental Officers, to work in a Technical Library Candidates should have higher school certificate or its equivalent in science or engineering Preference will be given to those who have reached a pass degree standard Experience in a technical library or library qualification would be an advantage The scales of pay are Experimental Officer (minimum age 26) £715 to £880 per annum (male), Assistant Experimental Officer, £288 10s (age 18) to £640 per annum (male) The successful applicants will be required to join the Authority's Principal Superannuation Scheme to be introduced shortly, and the salary scales quoted above will be enhanced to cover contributions Housing accommodation will be available within a reasonable period for married staff who live outside the radius of the Establishment's transport facilities —Application form from Senior Recruitment Officer, Atomic Weapons Research Establishment Aldermaston, Berks Quote Ref 332/WGE/34

TEA RESEARCH INSTITUTE OF CEYLON

Post of Director

Applicants are advised that the closing date for the above post has been extended to January 31 1955

UNIVERSITY OF BRISTOL

Applications are invited for appointment to the Melville Wills Chair of Botany, which becomes vacant on August 1, 1955

Particulars of the appointment may be obtained from the Registrar The University, Bristol, 8

LABORATORY TECHNICIAN REQUIRED for the Electrical Engineering Department for work in the electronics field Commencing salary according to age and experience, in the scale £315 by £15 to £450, plus London weighting (maximum £30) The successful applicant must join the contributory pension scheme —Application giving age and full details of experience, to Secretary, King's College, Strand, W C 2

RADIOGRAPHER REQUIRED AT THE Royal Northern Hospital Holloway Road, London, N 7 to work mainly on clinical applications of radioactive isotopes in therapy and tracer quantities Grading as Senior Radiographer or Radiographer, according to qualifications and experience —Application forms obtainable from Hospital Secretary, which should be returned by January 22 1955

JUNIOR TECHNICIAN, WITH INTEREST in electrical engineering, required to assist in the development and operation of Van de Graaff and neutron generator N C E E or equivalent qualification an advantage Salary according to age and experience —Applications in writing to the Director M R C Experimental Radiopathology Research Unit, Hammersmith Hospital, W 12

BIOCHEMIST (PRINCIPAL GRADE) REquired for Northern Group Hospital Pathological Services Salary scale £1 125 rising by annual increments of £50 to £1,375, plus £50 London weighting —Application forms obtainable from Hospital Secretary Royal Northern Hospital, Holloway Road, London, N 7

TECHNICIAN REQUIRED FOR HISTOlogy laboratory Must have experience in the main branches of histological technique and also in photomicrography Salary according to qualifications and experience —Apply to the Registrar The University Bristol 8 stating salary required

---

BIOCHEMIST SENIOR GRADE (NONmedical) required The successful candidate will be in charge of the routine work in the hospital's laboratory but his main duty will be research work carried out under the Director of Clinical Research Salary in accordance with Whitley Scales viz £835 by £40 to £1 035 by £25 to £1 060 by £20 to £1 080 Small house available —Applications stating qualifications age and experience together with the names of two referees should be sent to the Physician Superintendent Crichton Royal Mental Hospital Dumfries

---

APPOINTMENTS VACANT

HONOURS GRADUATES (FIRST OR second), interested in petroleum research and development work, are invited to apply for two senior appointments as follows 1 Chemist or Physicist, to undertake research investigations of a physico-chemical nature with minimum supervision 2 Chemical Engineer or Chemist, with experience in pilot plant development Candidates should be between 28 and 35 years of age Applications will also be considered from similarly qualified candidates between 23 and 28 for several junior appointments —Box 598, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1

VACANCIES OCCUR AT RECENTLY established laboratories engaged upon investigations relating to the nutrition of farm animals, for the following Chief Technician for animal house to be responsible for the cleanliness, feeding breeding, and maintenance of small animal stock colonies and to take part in feeding and metabolism experiments Applicants must be males between the ages of 25 and 35 and must be either Associates or Fellows of th Animal Technicians Association Laboratory Technicians are required for a laboratory engaged upon experimental nutrition The work involves both plant and animal biochemistry and limited experience in bacteriological and histological technique will be advantageous Applicants may be either male or female between the ages of 20 and 30 and must hold either the Associate or Fellowship of the Institute of Medical Laboratory Technologists Persons holding a recognized certificate of general education and with at least five years' laboratory experience may also apply —Applications for the positions advertised above should be addressed to "The Head of the Animal Nutrition Research Laboratories, Spillers Limited Middle Aston House, Middle Aston Steeple Aston Oxford"

RECENTLY QUALIFIED CHEMIST, B Sc or A R I C age 20 to 24, required as Assistant to Head of Research and Development Department The work involves both organic and inorganic syntheses up to and including pilot plant Five-day week, canteen facilities —Write to Works Director Thomas Morson and Son, Ltd , Wharf Road Ponders End Middlesex

---

ASSISTANT WORKS CHEMIST, PREFERably a graduate with some experience, aged 25 to 30, for development and control of organic chemical processes Capable of working on own initiative with a minimum of supervision —Apply with full details of training and experience and salary required, to Box 604 T G Scott and Son Ltd 143-147 Regent Street, London W 1

ENGINEER WANTED BY IMPERIAL CHEmical Industries Ltd , Alkali Division, Northwich Cheshire to do research on industrial chemical operations such as heat transfer and matter transfer Candidates aged 25 to 35 should possess an honours degree in engineering (preferably mechanical) and have received such practical training as is required for Associate Membership of the major Engineering Institutions Starting salary according to age and experience — Applications giving details of age and experience should be addressed to the Staff Manager

---

AGRICULTURAL JOURNALISM INTERnational journal seeks successor to present distinguished Editor Applicants must fully appreciate commercial significance of agricultural research Age, salary required, examples of published work and fullest details of education and experience to Box 601 T G Scott and Son, Ltd 143-147 Regent Street, London W 1

QUALIFIED CHEMISTS AND PHYSICISTS with either practical or academic ability are required to work on solid state problems connected with magnetic, semi-conducting and anodic oxides The posts are progressive —Box 602 T G Scott and Son, Ltd 143-147 Regent Street London W 1

RESEARCH DEPARTMENT OF MAJOR OIL Company has vacancies for Chemists or Chemical Engineers at its laboratories in Southern England Applicants must have good honours degree or equivalent with preferably some plant or industrial experience Age up to 30 Salaries appropriate to age and qualifications Good prospects —Write Box 594 T G Scott and Son Ltd 143-147 Regent Street London W 1

ENTOMOLOGIST REQUIRED TO CARRY out field trials overseas and to assist in abstracting and advisory work while in this country — Write giving full details to the Secretary The Murphy Chemical Co , Ltd , Wheathampstead, near St Albans Herts

---

MULLARD BLACKBURN WORKS, LTD

have vacancies for the following —

SENIOR PHYSICAL CHEMIST to ta
charge of the development laboratory wor
ing on ceramic magnetic materials Sor
experience of solid state physics and ch
mistry is essential The work is close
connected with a rapidly expanding indu
try, and offers considerable scope for a
vancement Salary depending upon ag
qualifications and experience, will be with
the scale £800 to £1,100 Ref M/24

SENIOR METALLURGIST required f
Works Laboratory Candidates should ha
a good degree in Metallurgy and conside
able experience in the investigation of fa
tory problems The work will be concern
with the metallurgical problems involv
in the manufacture of lamps and rad
valves, including the production of tungst
and molybdenum Some experience
powder metallurgy would be an advantag
Age 35 to 45 years Salary accordi
to qualifications and experience within t
scale £925 to £1 200 Ref M/26

METALLURGIST to work on the deve
opment of magnetic materials, includ
permanent magnet alloys Applicants shoul
possess a degree in Metallurgy Som
specialized knowledge of physical metallurg
would be an advantage Salary accordin
to age and experience within the scal
£600 to £800 Ref M/25

Apply in writing, giving full details, t
the Works Personnel Officer, Mullard Black
burn Works, Ltd , Philips Road, Black
burn, Lancs, quoting appropriate referenc

VACANCIES EXIST FOR YOUNG M
graduates in the Development Division of a C
pany manufacturing medicinal and pharmaceu
products Two of the posts are suitable for
didates having a special interest in labora
and pilot plant scale organic chemistry
the third is suitable for an organic chemist
a physical bias The laboratories are situ
in Surrey, and facilities exist for working
higher degrees Salaries within the range £60
£850 per annum Pension scheme —Write,
ing qualifications, etc , to Box 611, T G S
and Son, Ltd , 143-147 Regent Street, Lon
W 1

BACTERIOLOGIST OR BIOCHEMIST
quired, for work on bacterial metabolism in
tion to chemotherapeutics at Research Sta
near London associated with industrial conc
—Apply, quoting Reference NR/1 to Box
T G Scott and Son, Ltd , 143-147 Regent St
London W 1

KODAK, LTD HAVE A VACANCY
an Honours Physics Graduate in their Rese
Laboratories for research and development
in connection with the production of photogra
material and apparatus Candidates should
under 30 years of age —Apply by letter
Personnel Department (Factories), Heads
Drive Wealdstone Middlesex

YOUNG MAN HAVING A NATIO
certificate or equivalent in physics or electrical
gineering is required for a post in the meas
ment section of a development laboratory
Northamptonshire The work is connected
microwave equipment, but experience in this
is not essential Salary will be in accord
with age, etc —Box 608 T G Scott and
Ltd 143-147 Regent Street London W 1

IMPERIAL CHEMICAL INDUSTR
Limited 'Terylene Council, have a vaca
for an Assistant Statistician, to work for
months in Manchester and thereafter in Ha
gate on development problems associated
new synthetic fibres, especially 'Terylene
Written applications, giving brief details of qu
fications and experience to be sent to Staff M
ager Hookstone Road Harrogate

GRADUATE CHEMIST METALLURG
or Chemical Engin er required to deal with pr
lems relating to the installation of electropla
plant and process control Applicants must h
completed military service and be willing to tra
—Apply Electro-Chemical Engineering Co , L
161 Queens Road Weybridge Surrey

LADY CHEMIST GRADUATE OR H N
required for analysis of electroplating and al
solutions —Apply, Electro-Chemical Enginee
Co , Ltd , 161 Queens Road Weybridge, Sur

ɪITISH CHROME AND CHEMICALS LTD. ire two physical chemistry graduates with re- h experience, preferably in industry, capable ading small teams with energy and persist- . One team to investigate phase relationships ystems at elevated temperatures, the other to with problems of a general nature in electro- istry and surface chemistry, and with the lopment of physico-chemical methods of ysis. Salaries will be according to experience qualifications, and the successful applicants be eligible for membership of an approved ion scheme after twelve months' service.— ications, which will be regarded as confiden- giving the fullest details of experience and fications as concisely as possible, should be essed to W. H. Morrow, Technical Director, sh Chrome and Chemicals Ltd., Urlay Nook. escliffe, Stockton-on-Tees.

0 PER ANNUM AND DEPARTMENTAL sibility offered to Designer with experience , pressure and temperature sensitive in- nts and small electro-mechanical move- Surrey area.—Write, Box 609, T. G. nd Son, Ltd., 143-147 Regent Street, Lon- V.1.

IENTIFIC PERSONNEL OFFICER RE- ed for Dunlop Research Centre near Birm- am, serving the Dunlop Group. Chief duties be the recruitment of graduate staff and the al working arrangements for research person- Should already have experience in the selec- of science graduates for industry possibly on niversity appointments board, and accustomed confer with professors and teaching staff of ersities and technical colleges. Would be re- ed to exercise initiative in contacting managers find out what staff is required, suggesting the s of people to be engaged, deciding where people are most likely to be found and in ing them. This is a high level appointment salary will be appropriate to qualifications experience.—Applications should be made to f Training and Appointments Office, Dunlop bber Company Limited, Fort Dunlop, Erding- , Birmingham, 24.

OOTS PURE DRUG CO., LTD., REQUIRE oman graduate in their Microbiology Division carry out routine assays and investigations into y techniques on antibiotics and vitamins. Ex- ience in this field of microbiology would be advantage and salary will be according to ex- ience and qualifications.—Applications to the sonnel Manager, Station Street, Nottingham.

IEDICAL REPRESENTATIVES. BRITISH idiary of leading American ethical pharma- ical house have vacancies in several areas for ical Representatives. Good starting salary expenses. Car provided.—Applications, with particulars of age, qualifications, experience salary required, in writing only, to the ager, Pfizer, Ltd., 137-139 Sandgate Road, estone, Kent.

DEVELOPMENT CHEMIST IS REQUIRED ork on the applied chemical aspects of pro- and product development in glass fibre manu- are. He will be required to work in close boration with the engineering section in the gn and operation of pilot plant, and to evalu- the properties of new adhesives and coatings glass fibres. There will be opportunities for lamental work in the field of polyester glass inates. Applicants should have a good de- in chemistry, and be between the ages of nd 35 years.—They should write, stating their qualifications, experience and salary re- ed, to the Secretary, Fibreglass, Limited, enhead, St. Helens.

SSISTANT, WITH INTEREST IN PROPER- of matter, required for research on behaviour ackaging materials under shock. A familiarity electronic circuits useful. General certificate education (advanced level) in physics and hematics preferred, with laboratory experience. 5 to £475. Male applicants should have com- ed or be exempt from National Service.— lication forms from Secretary, Printing, kaging and Allied Trades Research Associa- , Randalls Road, Leatherhead, Surrey. (Ref. /2).

IBRARIAN (WOMAN) REQUIRED FOR ial library in progressive firm of petroleum. or chemical engineers. The library is the lligence centre for information in all fields engineering and chemistry, and in matters of le, economics, travel, etc. It is a member of LIB. Applicants should have a science degree preferably some experience of library work a knowledge of French and German. Entry good pension scheme at age 30.—Applications the Secretary, Whessoe Limited, Darlington, ore January 22, 1955.

DESIGN AND DEVELOPMENT

BRITISH OXYGEN ENGINEERING,
LIMITED

Applications are invited for a senior appointment in a Development Group engaged on gas separation projects in a wide and expanding field offering considerable scope to those with special interest in thermodynamics and physical chemistry. Applicants should hold at least a second-class honours degree, and have had previous experience on development or research work. The Company is based in North London, on the North Circular Road, with easy access to main 'bus and train routes. Staff pension scheme. Successful applicants currently resident outside the North London area may be given assistance in obtaining housing accommodation.

Applications should be addressed to the Personnel Manager, British Oxygen Engineering, Ltd., Angel Road, Upper Edmonton, London, N.18.

ELECTRONIC COMPUTERS

Ferranti Ltd., have vacancies for men and women interested in the application of electronic digital computers in problems in: (1) Electrical, Mechanical, Civil and Chemical Engineering, Aeronautics, Crystallography, Nuclear Physics, Optics, etc. Candidates should have first- or second-class honours degrees or equivalent qualifications in mathematics, physics, engineering or chemistry. Experience in numerical methods an advantage. Reference CS1. (2) Accountancy, Actuarial Science, Operational Research, Production Engineering, Statistics, etc. Candidates for these posts should be able to show experience in one of these fields or have qualifications indicating their suitability, for example, membership of appropriate professional body, or first- or second-class honours degrees in mathematics, economics or statistics. Reference CS2. In both groups experience of computing work will be of value, but is not essential. Previous knowledge of electronic computers would not be assumed. Permanent staff appointments with pension benefits.

Application forms from Mr. T. J. Lunt, Staff Manager, Ferranti Ltd., Hollinwood, Lancs.

BOOTS PURE DRUG CO. LTD., HAVE A vacancy in the Research Department for a young graduate for biological work in connection with research on chemotherapy of protozoal diseases and on related topics. Candidates should have a degree in an appropriate biological science. Knowledge of microbiology is essential; some knowledge of biochemistry would be an advantage. Previous research experience in the field of protozoology would be especially valuable.—Applications to Personnel Manager, Station Street, Nottingham.

J. SAINSBURY, LTD., REQUIRE A FOOD Analyst in their Laboratories at Blackfriars. Previous experience in food analysis essential. A minimum salary of £600 per annum is offered. The post will be permanent, and there is a staff pension scheme and full staff facilities.—Applications should be made to the Personnel Manager (F.A.), J. Sainsbury, Ltd., Stamford House, Stamford Street, Blackfriars, S.E.1.

PATENT AGENTS IN LIVERPOOL REquire Technical Assistant willing to work under guidance to qualify in the profession; adequate grounding in electrical engineering or physics essential, preferably to degree standard, for work in telecommunications and electronics; knowledge of German and French an advantage; more important requirements are power of quick and accurate analysis, balanced judgment and clear, unemotional thinking; good prospects for man who is content with predominantly desk work with wide range of interest.—Fullest details to Box 605, T. G. Scott and Son, Ltd., 143-147 Regent Street, London, W.1.

LEADING OIL COMPANY HAVE VACancy for Chemist in their Head Office. Applicants should be in possession of degree or equivalent, and if possible wide experience in the petroleum industry. Work to cover lubricants, solvents, bitumens, fuels, etc. Age 30 to 35 years. Salary according to age and qualifications.—Applicants should apply, giving full particulars of qualifications and experience, quoting H.3115, to Box 7154, c/o 191 Gresham House, E.C.2.

Advertisers please note. You must add "Apply Employment Exchange" unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order.

LIBRARIAN-INFORMATION OFFICER REquired in Research Laboratories for abstracting, information services and preparation of bibliographies and bulletins. Applicants should preferably have science degree, library experience and knowledge German and French. Position superannuated and five-day week in laboratories shortly moving 20 miles north of London.—Applications, treated in strict confidence to Box 603, T. G. Scott and Son, Ltd., 143-147 Regent Street, London, W.1.

A LARGE INDUSTRIAL UNDERTAKING requires the services of a Chemical Engineer, to assist in the technical management of an associated company in Norway. A knowledge of electrometallurgy, particularly calcium carbide manufacture, would be an advantage, but is not essential, provided that the candidate has had at least five years' experience in the chemical or metallurgical industries, including some experience as a production executive. The successful applicant will be seconded to the company in Norway for not less than one year, following which an opportunity of service in the U.K. in a similar capacity is likely to arise. Salary will be commensurate with qualifications and experience, but not less than £1,000 per annum.—Details to Box AM7099, AK Advg., Ltd., 212a Shaftesbury Avenue, London, W.C.2.

BOOTS PURE DRUG CO., LTD., REsearch Department, Veterinary Science Division, Thurgarton, require a Laboratory Technician with experience in biological techniques, and preferably with some knowledge of parasitology.—Applications, giving two references, to be sent to the Personnel Manager, Station Street, Nottingham.

FOR SALE AND WANTED

FOR SALE. U.V. SPECTROPHOTOmeter. Hilger Small Quartz Spectrograph and Spekka Photometer; complete with accessories. Excellent condition. £300. Can be inspected by appointment.—B.R.P.R.A., 48 Tewin Road, Welwyn Garden City.

RECORDING MILLIAMMETER REQUIRED. Sensitivity of [illegible] illiampere full scale deflection. Input impedance not less than 3,000 ohms. Pen response approximately 1 second full scale deflection. Chart speed of at least 12 in. per hour.—Anyone having such an instrument surplus and in good working order should write, giving details and price required, to Box 610, T. G. Scott and Son, Ltd., 143-147 Regent Street, London, W.1.

FOR SALE, HILGER MEDIUM QUARTZ Spectrograph. Type E498, flat field, fitted with Barfit Optical Bench. This instrument has been used for absorption spectroscopy and includes the following accessories: Hilger Spekker Photometer, High Voltage Set for Spark Source. Set of quartz absorption cells, including two Baly tubes and two Hilger Micrometer cells. All in excellent condition.—Box 606, T. G. Scott and Son, Ltd., 143-147 Regent Street, London, W.1.

MISCELLANEOUS

ESTABLISHED LABORATORY FURNISHER located Newcastle, covering four Northern Counties, Yorkshire and South Scotland, wishes to link up with manufacturers of special equipment for laboratories. Complete facilities offered including sales, technical services and drawing office.—Anyone interested in increasing their turnover please write to Box 597, T. G. Scott and Son, Ltd., 143-147 Regent Street, London, W.1.

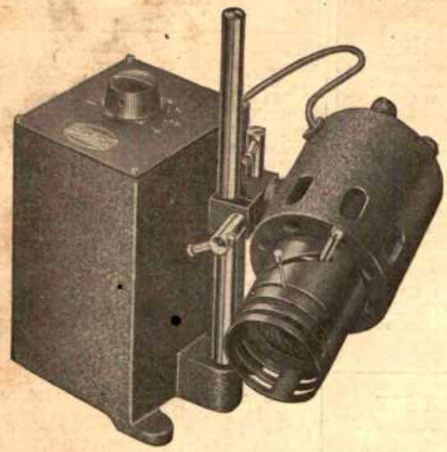
ROBERT GRAVES, ANTONY FLEW AND Naomi Mitchison write in January "Literary Guide," now on sale, 1s.—Specimen copy from Dept. W, 12, St. James's Place, S.W.1.

ELECTRONICS APPLIED TO INDUSTRY. Learn the basic principles and applications with our modern self-study course. Experimental work included if required.—Free Brochure from E.M.I. Institutes, Dept. N.56, London, W.4. (Associated with H.M.V.)

TECHNICAL SERVICES BUREAU SPECIALizes in services to scientific and technical authors. Preparing MS. for press, indexing, proof-reading, translations, secretarial work.—17 Clifford Road, New Barnet, Herts. BARnet 4730.

TRANSLATIONS OF TECHNICAL MATTER on Physical Sciences from French and Spanish.—Waldron, 18 Hayes Close, Chelmsford, Essex.

BECK TENSLITE LAMP



A powerful source for all methods of microscope illumination. Built-in transformer and switch for regulating intensity. Full adjustment for height from table level to 10 in. above, with tilting motion. Centring adjustment for bulb.

Corrected focussing condenser, iris diaphragm and fitting for colour screens. Solid source filament, 6 volt 48 watt for A.C. 200 to 250 volt.

R. & J. BECK LTD. **69/71 MORTIMER STREET**
LONDON, W.1

HAWKSLEY'S

BRITISH MADE

HAEMACYTOMETERS
HAEMOGLOBINOMETERS
SEDIMENTOMETERS
and other apparatus for
BLOOD DIAGNOSIS

COLORIMETERS

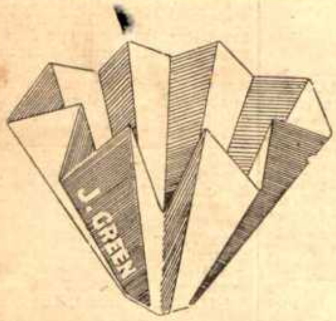
McMaster
WORM EGG COUNTING CHAMBERS

EEL WORM COUNTING CHAMBERS

Distributors for Great Britain of
COOKE MICROSCOPES
British made by Cooke, Troughton & Simms, Ltd.

HELBER (Bacteria)
and
MANNERS (Eosinophil)
COUNTING CHAMBERS

HAWKSLEY & SONS LTD.
17 NEW CAVENDISH STREET, LONDON, W.1
Telephone: WELbeck 3859 *Telegrams:* "Diffract, Wesdo, London"



GREEN'S PURE FILTER PAPER

This is our "simple fold". The price is lower and it saves shipping space for export

See price list NG

•

J. BARCHAM GREEN LTD.
Maidstone • England

THE TECHNE TEMPUNIT

This self contained constant temperature control unit has been widely sold and in its new form has features that place it in a class by itself. The unique pneumatic control system has all the sensitivity of electrical contact methods with far greater dependability and longevity.

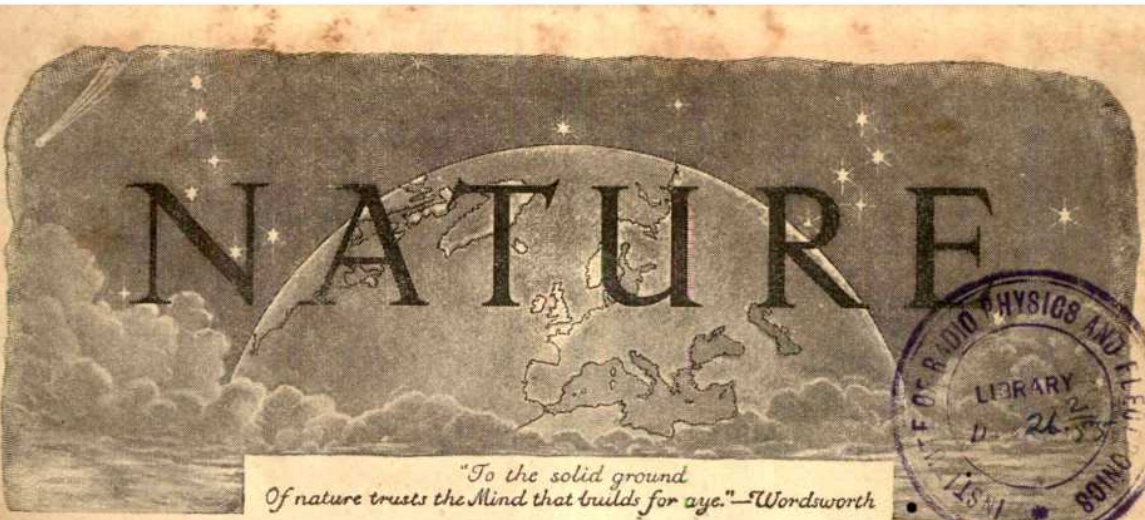
Control is ± .05°C.

Range from room temperature to 96°C.

For full details write to:

TECHNE (CAMBRIDGE) LTD · DUXFORD · CAMBRIDGE · ENGLAND

Printed in Great Britain by FISHER, KNIGHT & Co., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & Co., LIMITED, at St. Martin's Street, London, W.C.2, and ST. MARTIN'S PRESS, INC., 103 Park Avenue, New York 17, N.Y., U.S.A.—Saturday, January 1, 1955.



*"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth*

INSTITUTE OF RADIO PHYSICS AND ELECTRONICS
LIBRARY
D. 26.2.55

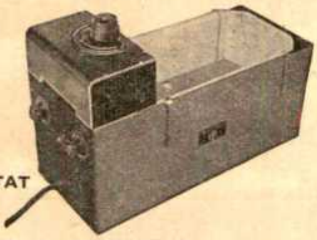
VOL. 175, No. 4445 SATURDAY, JANUARY 8, 1955 TWO SHILLINGS

NEW TECHNE
4 GALLON BATH

The new Techne 4 gallon bath has self contained pneumatic control (pat. applied for) for greater sensitivity and longer life.

- ★ INDICATING THERMOSTAT
- ★ 3 HEATING RANGES
- ★ ADJUSTABLE TRAY
- ★ CIRCULATION TO EXTERNAL APPARATUS
- ★ CONTROL BETTER THAN ± 0.02 °C. AT 40°C.
- ★ BRUSHLESS MOTOR
- ★ MAGNETIC THRUST BEARING
- ★ NO SUBMERGED BEARINGS
- ★ SPECIAL RACKS TO ORDER

TECHNE (CAMBRIDGE) LTD . DUXFORD . CAMBRIDGE . ENGLAND



Tinsley

STANDARD CADMIUM CELLS

Single and double types in wooden cases or in metal cases as illustrated.

Reliable single or double miniature types mounted in plastic cases, E.M.F. 1.01859 abs. volts at 20° C. Temp. coeff. —40 μV/1° C. Low internal resistance.

Dimensions 3¼ in. × 1⅝ in. × 1$\frac{3}{16}$ in.

Non-temperature coefficient cells for industrial use.

All types of unmounted standard cells can be supplied in quantity from stock.

H. Tinsley & Co., Ltd., Werndee Hall, London, S.E.25

Telephone: ADDiscombe 1400 and 3680

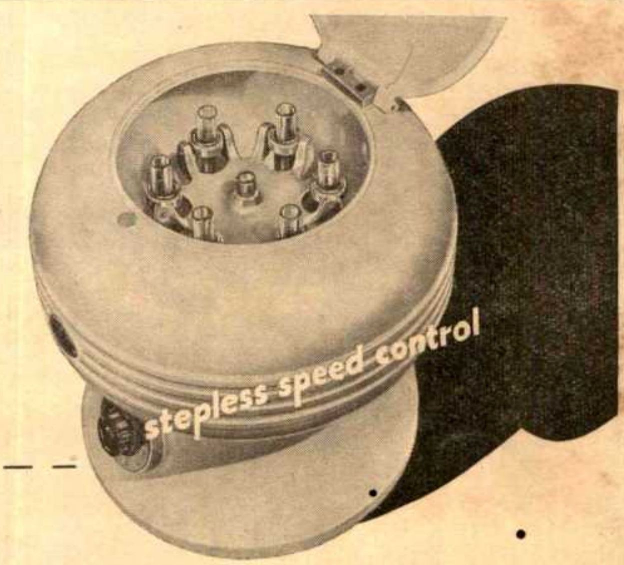
MSE

"MINOR"
CENTRIFUGE

This 200 ml. capacity centrifuge is versatile, fast and reliable, and its stepless speed control puts it in a class of its own. There is a choice of 6 different interchangeable swing-out and angle heads, together with a multiplicity of buckets, cups and adaptors. Universal AC/DC motor. Speeds up to 4,600 r.p.m. (2,734 × g.). *Write for Publication No.* 137.

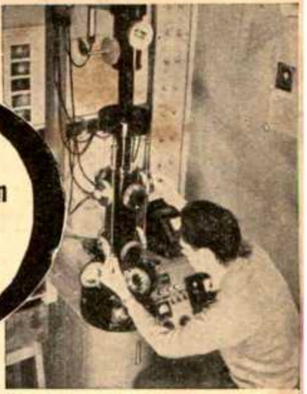
FOR YOUR FILE: *MSE Publication* 888 *gives a brief review of the entire range of MSE Centrifuges, Microtomes and Laboratory Blenders. Have you had your copy?*

MEASURING & SCIENTIFIC EQUIPMENT, LTD., Spenser Street, London, S.W.1 ● VICtoria 5426



HIGH VACUUM HARNESSES THE ELECTRON

. . . to provide critical information on CRYSTALLINE structures!



Polished diamond facet showing crystalline structure of surface layer

The EDWARDS Electron Diffraction Camera is a striking example of the way in which high vacuum has harnessed the electron for providing critically accurate information regarding surface phenomena during research on lubrication and oxidation, etc., the structure of metals, ceramics, plastics and polymers.

The NEW Edwards camera offers diffraction workers a high performance standard with an ingenious centralized control system—all controls, including that of the remotely controlled H.T. system (to eliminate any electrical interference), are compactly grouped on the camera body.

W. EDWARDS
& CO. (LONDON) LTD
MANOR ROYAL · CRAWLEY · SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

for better vacuum service

BRANCHES: GLASGOW & TORONTO. AGENTS THROUGHOUT THE WORLD

Add this skilled worker to your laboratory staff . . .

If you manipulate glass, you need the Scorah Oxy-Coal-Gas Blowpipe—the Blowpipe that gives the right size flame by a simple turn of the turret. It is the most efficient Blowpipe ever produced, and once installed in the laboratory will be in constant use. It will render instant valuable service in making that new idea or gadget, modifying existing apparatus or repairing the little casualties. Your staff will have the opportunity to develop skill in handling 'Pyrex,' 'Phoenix' or 'Hysil' with a tool specially designed to change glass-blowing from a frustration into a fascination. For the more expert it provides much greater speed on the job, plus certainty and mastery via smoothly burning, quiet, stable flames of just the right size for the work in hand.

Price
£19. 10. 0.

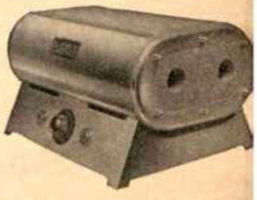
Send for descriptive leaflet.

L.V.D. SCORAH M.Sc. 44, NORTHFIELD RD. BIRMINGHAM, 30
phone: KINGS NORTON 1885

Laboratory Tube

MUFFLES

Wild-Barfield laboratory tube muffles are of single or twin tube types. Normal maximum operating temperature 1050°C. Two sizes are available, either 12″ or 20″ long, designed for combustion tubes up to 1½″ outside diameter. A tub muffle for high temperatures—1350°C./1400°C.—as well as a range of horizontal rectangular muffles are available. Full details will gladly be supplied.



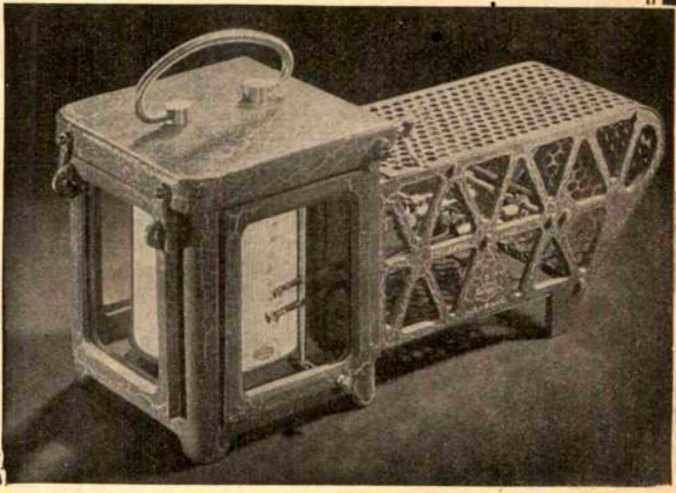
WILD-BARFIELD
ELECTRIC FURNACES
for all heat-treatment purposes
Wild-Barfield Electric Furnaces Ltd.
23, Elecfurn Works, Watford By-Pass, Watford, Herts.
Telephone: Watford 6091.

CASELLA
LONDON

CASELLA
THERMO-HYGROGRAPHS

FOR ACCURATE CHECKING OF TEMPERATURE AND HUMIDITY

If you maintain temperature and humidity control our instrument will give you a permanent and scientific check on that control and will show instantly any variation in temperature or humidity. It will enable you to compare manufacturing results with the actual conditions ruling at any previous moment.



Further details from

C. F. CASELLA & Co. Ltd.
REGENT HOUSE
FITZROY SQUARE
LONDON, W.1
Telephone: ★EUSton 3944

Member Scientific Instrument Manufacturers Association of Great Britain

---

DORAN

MINI STANDARD CELL

Catalogue No. E.4114

This modified version of the well-known Weston Normal Standard Cell provides a small compact unit which can be used in any position, and is sufficiently robust to withstand considerable rough treatment without ill effect. Experience in manufacture and use over a period of several years has shown it to be completely reliable and stable. The chemical construction, performance and life are the same as that of the H type cell. These cells can be supplied in bakelite case with terminals as illustrated or slightly smaller with soldering posts for instrument mounting.

Further details in List 111

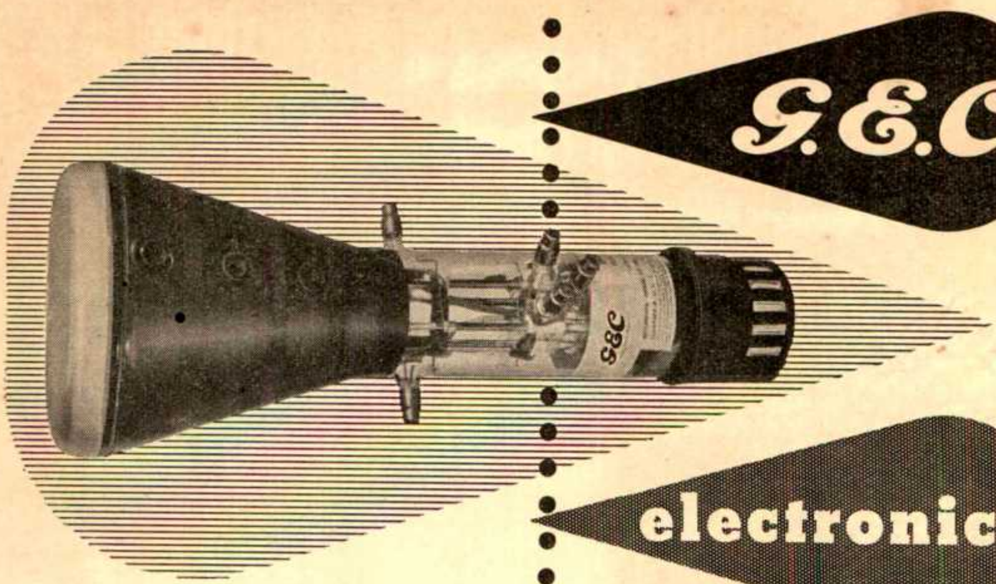
Dim. 4¼″ × ¾″ × ¾″ Weight 2 ozs.

Tel.: STROUD 462

DORAN INSTRUMENT CO. LTD.
STROUD, GLOS.

London Office:
Tel.: ADD 2369

G.E.C.



electronics

Special purpose Cathode Ray Tubes
for Research and Industry

A range of cathode ray tubes is available for use in specialised applications such as the observation and recording of high speed transient phenomena, where the high capacitances and other limitations of the usual type of instrument tube would result in distortion or complete suppression of the trace.

Typical applications of these special tubes include high voltage cable testing, insulator overload and breakdown testing, cable fault finding by quasi-radar technique and the investigation of high voltage switching phenomena.

They are also suitable for use in laboratory oscilloscopes.

Brief details of some of the more popular types are given below. The tubes are of the all-electrostatic type, with heater ratings of 4V, 1.0A (approx.).

401 CAHA
408 CAHA
Rating.
Va3 (max) 1.5kV
Vp.d.a.3 3.5kV
Sx (av.) 0.090mm/V
Sy (av.) 0.100mm/V
Screen: 401 CAHA. Green-visual
408 CAHA. Killed blue—photographic
Base: B9G (pressed glass)

4cm. dia. high vacuum monitor tubes with one stage of post deflection acceleration. For use in laboratory oscilloscopes, multi-channel strain-gauge recording equipment, etc.

908 BCC
Rating.
Va3 (max.) 10kV
Sx (av.) 400/Va3 mm/V
Sy (av.) 750/Va3 mm/V
Screen: Killed blue—photographic
Base: B12D

A 9cm. dia. flat screen high speed recording tube with a low capacitance deflecting system. The connections to the plates and final anode are brought out through side-arms. Writing speeds of the order of 30,000 km/sec. are possible, and transients of the order of 10^{-9} sec. may be recorded.

908 CARA
Va3 4kV
Vp.d.a. 8kV
Sx (av.) 0.085 mm/V
Sy (av.) 0.12 mm/V
Screen: Killed blue—photographic
Base: B12D

A 9 cm. dia. flat screen high speed recording tube with one stage of post deflection acceleration. For use where the special features of the 908 BCC cannot be employed to full advantage. The Y plate connections and final anode are brought out through side arms.

1601 ABC
Va3 (max.) 5kV
Sx 660/Va3 mm/V
Sy 1100/Va3 mm/V
Screen: Green—visual
Base: B12D

A 16cm. dia. flat screen high speed oscillograph tube. The construction is of the low capacitance type with the deflector plates and final anode connections brought out through side arms.

1608 BCCA
Va3 (max.) 3.5kV
Vp.d.a.3 (max.) 10kV
Sx (av.) 0.15mm/V
Sy (av.) 0.27mm/V
Screen: Killed blue—photographic
Base: B12D

A 16cm. dia. flat screen tube of similar low capacitance construction as the 908 BCC, but with three stages of post deflection acceleration. This tube will achieve similar writing speeds and recording periods as the 908 BCC, and is recommended for use where the deflecting potentials available are limited.

Alternative screens are available including long after-glow and white and blue aluminised types.

Other types of special tubes are available including:

Double gun tubes. Storage tubes.
Television monitor tubes.
Conical deflection systems tubes for radial time bases. Monoscopes, etc.

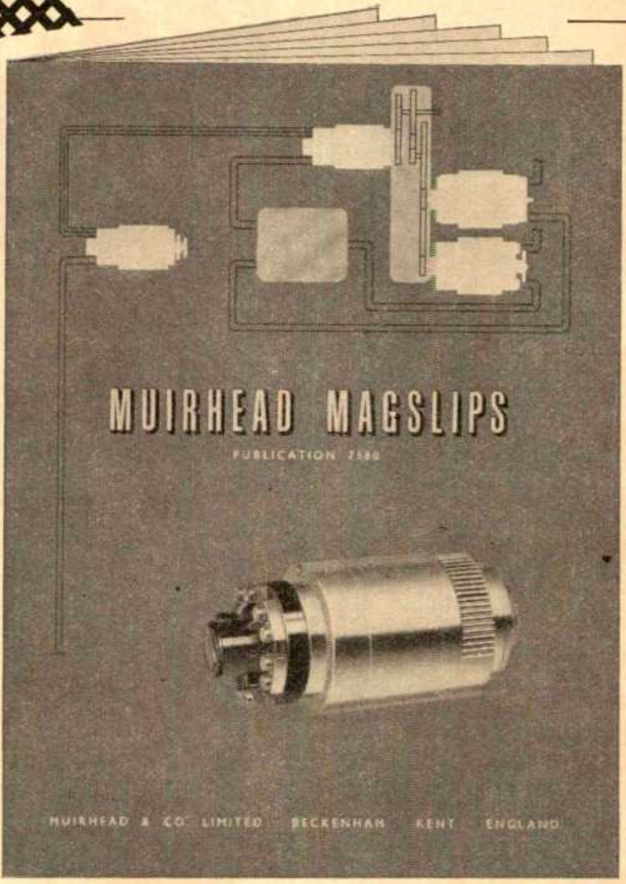
Write to Osram Valve and Electronics Dept. for full technical details

THE GENERAL ELECTRIC COMPANY LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

THIS BROCHURE DESCRIBING

MUIRHEAD MAGSLIPS

IS ISSUED FREE ON REQUEST



MUIRHEAD MAGSLIPS

PUBLICATION 7580

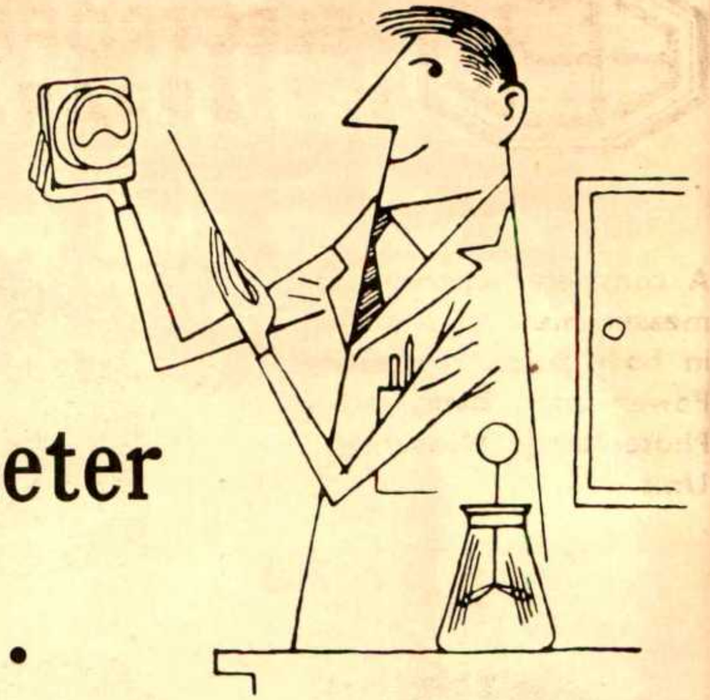
MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

WRITE UNDER YOUR BUSINESS · LETTERHEAD
FOR PUBLICATION 7580

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

MAKERS OF HIGH GRADE PRECISION ELECTRICAL INSTRUMENTS

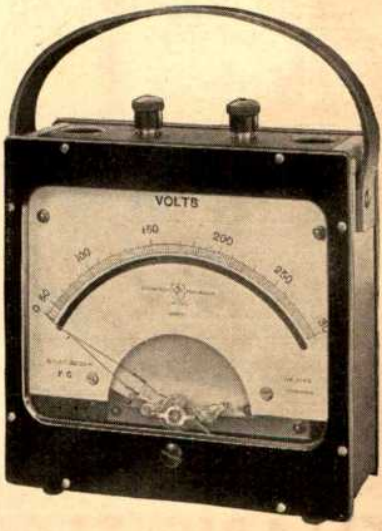
130

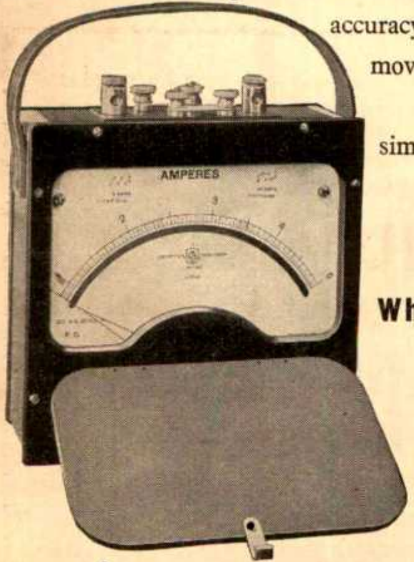


An ammeter

in hand . . .

is worth two on the other side of the laboratory. Portable instruments can save a lot of time when bench measurements are frequent, but they must essentially be of robust construction. Illustrated here are a portable voltmeter and a portable two-range ammeter fitted with hinged lid. These moving-iron instruments are provided with an 8 in. scale and have an accuracy equivalent to those with moving-coil or dynamometer movements. They are of simple but extremely robust construction.





When it comes to ELECTRICAL INSTRUMENTS . . .

you've got to hand it to

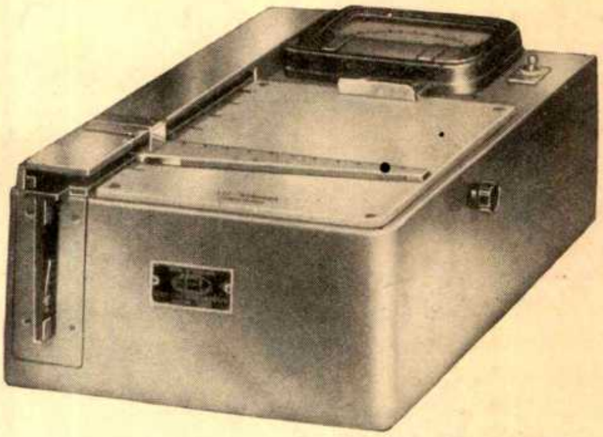
Crompton Parkinson
LIMITED

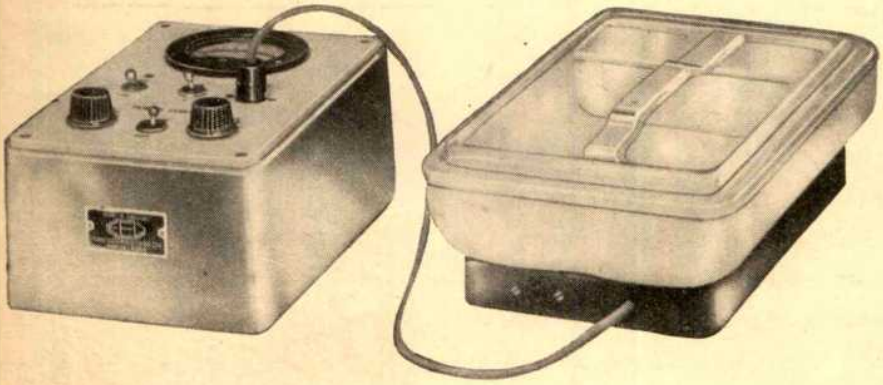
ELECTRICAL EQUIPMENT

CROMPTON HOUSE, ALDWYCH, LONDON, W.C.2. TELEPHONE : CHANCERY 3333

ELECTROPHORESIS APPARATUS

A complete apparatus for measurement of protein in body fluids, comprising Power Unit, Bath, and Photoelectric Measuring Unit





Simple to use, rapid, accurate, robust, and low priced

Full details readily available from

EVANS ELECTROSELENIUM LTD

Sales Division 25, Harlow, Essex

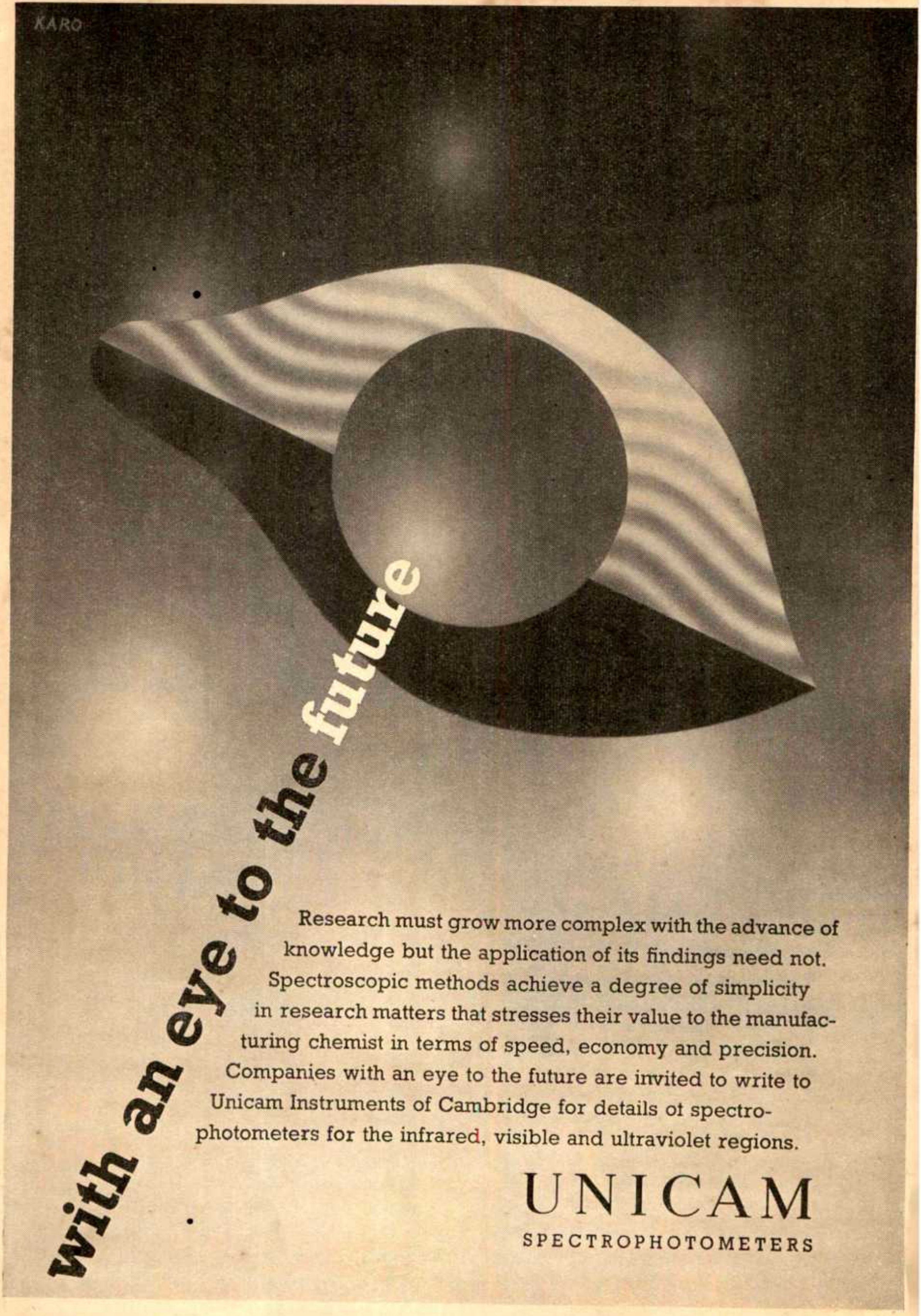
Representatives for Sales and Service

MANCHESTER AREA: Messrs. A. M. Lock & Co., Ltd.,
Crompton Street, Chadderton, Oldham, Lancs.

NORTH OF ENGLAND: Messrs. Electricals, Ltd.,
14, Claremont Place, Newcastle-upon-Tyne, 2.

SCOTLAND: Messrs. Atkins Robertson & Whiteford, Ltd.,
92–100, Torrisdale Street, Glasgow, S.2.

SELENIUM PHOTOCELLS
NEPHELOMETERS
PHOTOMETERS
DENSITOMETERS
ABSORPTIOMETERS
SPECTROPHOTOMETERS
OPACIMETERS
FLAME PHOTOMETERS
COLORIMETERS
REFLECTOMETERS, ETC.


KARO
with an eye to the future

Research must grow more complex with the advance of knowledge but the application of its findings need not. Spectroscopic methods achieve a degree of simplicity in research matters that stresses their value to the manufacturing chemist in terms of speed, economy and precision. Companies with an eye to the future are invited to write to Unicam Instruments of Cambridge for details of spectrophotometers for the infrared, visible and ultraviolet regions.

UNICAM
SPECTROPHOTOMETERS

NATURE

No 4445 SATURDAY, JANUARY 8, 1955 Vol 175

CONTENTS

Page
Leadership in Local Government 49

The Resistance to Evolutionary Change By Prof C H Waddington, F R S 51
St Mary's Hospital Medical School By Prof R Cruickshank 52
Experimental Nuclear Physics By Sir John Cockcroft, K C B , C B E , F R S 53
Radioisotope Techniques in Diagnosis, Therapy and Research By F P W Winteringham 54

The International Geophysical Year, 1957–58 By Prof Sydney Chapman, F R S 55
Precision Electrical Measurements By Dr L Hartshorn 57
British Iron and Steel Research Association Open Day at the Battersea Laboratories 59
The New Megavoltage Radiotherapy Unit at Manchester 60

Obituary

Prof G H Shull By Prof S C Harland, F R S 62

News and Views 62

Research and Industrial Productivity 66
X-Ray Apparatus and Associated Techniques Exhibition in London By Dr U W Arndt 68
The Age of the Universe 68
Royal Observatory, Cape of Good Hope Report for 1953 69
The Function of Hydroxyproline in Collagens By Dr K H Gustavson 70
Anterior-Pituitary – Hypothalamic Relations in the Ferret By A P D Thomson and Prof S Zuckerman, C B , F R S 74

Letters to the Editors

Observation of Desert Locust Swarms by Radar —Dr R C Rainey 77
Widespread Diurnal Variations of Effective Slope of the Ionosphere —H A Whale 77
Radio Astronomy in Hawaii —Grote Reber 78
Carbon–Carbon and Carbon–Hydrogen Distances in Simple Polyatomic Molecules —Dr G Herzberg, F R S , and Dr B P Stoicheff 79
Corrosion Fatigue of Low Alloy Chromium–Molybdenum Steel as affected by the State of Heat Treatment —D S Kemsley 80
A Light Condenser for Spectrographical Purposes —Dr Kenzo Toishi and Senzo Miura 81
Uniform Field Breakdown in Air —Dr R F Saxe 82
Preparation of Solid Solutions of Free Radicals at Room Temperature —D Bijl and A C Rose-Innes 82
Solubility of Oxygen in Water —Dr J A Allen 83
Oxygen Exchange between Nitrous Acid and Water —Dr C A Bunton, D R Llewellyn and G Stedman 83
Structure of Sterculic Acid —J P Verma, Dr Bhola Nath and Dr J S Aggarwal 84
Separation of Saponins by Paper Chromatography —N L Dutta 85
Techniques for labelling Trees with Radioactive Phosphorus —P B Cornwell 85
Acceleration of Citrate Oxidation in Yeast by Aspartic Acid —E C Foulkes 87
Distribution of Adrenaline and Noradrenaline in the Adrenal Medulla —Dr O Eranko 88
Cyanide-resistant Mitochondria from the Spadix of an *Arum* —Dr W O James, F R S , and Daphne C Elliott 89
Chelated Iron Compounds for the Correction of Lime-induced Chlorosis in Fruit —Dr C Bould 90
Acarine Disease of the Honeybee and Temperature —E P Jeffree 91

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO , LTD , ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd , Crown House, 143–147 Regent Street, London, W 1
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

DIFCO

DIFFERENTIAL MEDIA

BACTO-RUSSELL DOUBLE SUGAR AGAR
—a useful aid in identification of newly isolated strains of intestinal bacteria

BACTO-KRUMWIEDE TRIPLE SUGAR AGAR
—an excellent medium for identification of intermediate strains of the colon-typhoid group.

BACTO-TRIPLE SUGAR IRON AGAR
—combines the fermentation reactions obtained on Krumwiede's Medium with hydrogen sulphide production

BACTO-PHENOL RED MEDIA
—particularly adapted for determination of fermentation reactions of bacteria Complete agar and broth media containing carbohydrates are available, as are also the basic media without carbohydrate

BACTO-PURPLE MEDIA
—basic media, excellently suited for addition of carbohydrate for study of bacterial fermentation at an acid reaction

Specify "DIFCO"
THE TRADE NAME OF THE PIONEERS
In the Research and Development of Bacto-Peptone and Dehydrated Culture Media

BAIRD & TATLOCK (LONDON) LTD.
Sole Agents for Great Britain and India
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?
Suppliers to all Leading Universities, Public Libraries and Institutions of the World
Catalogues issued

★

SELLING?
Specialists in Scientific, Technical Books and Publications of all Learned Societies

★

Why not consult us first?

102 WIGMORE-STREET, LONDON, W.1
• *Telephone Wel 7948, Amb 5991*

STAINS & REAGENTS
for Microscopy
as used and tested in our own Microscope Slide Dept

We are the Sole Manufacturers of
"EUPARAL"—made by Prof. Gilson's original process.
"MURRAYITE"—spirit proof cement
"MERSOL"—the Immersion Oil that always remains bright and clear
See new Catalogue S/5N now available

FLATTERS & GARNETT LTD.
309 Oxford Road, Manchester 13
Over 50 Years' Service to Microscopy

LEADERSHIP IN LOCAL GOVERNMENT

NEITHER Mr H Morrison, in his book "Government and People a Survey from the Inside", nor the contributors to the symposium on the Civil Service in the current issue of the *Political Quarterly* made more than passing reference to the question of local government in Britain. Mr Morrison, however, referred specifically to one point which deserves further attention and which, if neglected, may well frustrate all attempts to improve the efficiency of the Civil Service and the smooth functioning of the task of government, namely, the serious effects of over-work on Ministers and the senior Civil servants He says "It is a nice point to consider which is the most injurious to the public interest an overworked Minister or an overworked Civil servant" Mr Martin Lindsay comments in similar terms in an article entitled "Government by Endurance".

Both are dangerous and undesirable, and sometimes unavoidable, even if a government does not overload itself or the organization by which the task of government is performed. Mr. Morrison's observations here are a sober warning against over-loading the legislative programme at the behest of a political party without regard to the administrative consequences, and by implication they are a salutary reminder of the need in a democracy for leadership and responsibility. Statesmanship, wisdom and judgment are required to translate a political programme into executive action and legislation, and if they are disregarded through political prejudice or passion, trouble is bound to ensue. Indeed, Mr. Morrison concedes that it is probably more dangerous for the higher Civil servants to be over-worked than for Ministers to be over-worked It is the Civil servants who are responsible for the detailed planning, thinking and drafting, and bad mistakes may be made by them without the Minister being aware of the position

The Crichel Down episode shows that there is some substance in this, even when mistakes have arisen through bad judgment rather than over-work. If, however, the burden on Ministers and on Civil servants is to be reduced, more attention must be given not merely to the administrative structure of the Civil Service and of the Cabinet system, but also to the functions of Parliament and the way they are performed It will not be sufficient merely to see that the programme of legislation is reasonably proportioned to the amount of Parliamentary time available and to the demands it makes alike on Ministers and Civil servants It is essential also to see that, without impairing the essential functions of the House of Commons as the watch-dog over public expenditure and the guardian of individual citizens against official injustice, Parliament is not distracted from its larger duties by demands which could be equally or better met at the regional or local level

The Government's decision, announced by the Prime Minister on November 18, to accept the proposals of the report of the Royal Commission on Scottish Affairs and to transfer to the Secretary of State for Scotland certain responsibilities in Scotland of the Minister of Transport and Civil Aviation, of the Lord Chancellor and of the Minister of Agriculture and Fisheries is a step in the right direction The case for local government reform is in fact closely connected with this need for devolution The importance of Parliament as the great forum of debate on public policy, and the undoubted advantages of centralization in certain technical fields, do not remove the need for vigorous, independent and healthy local government. While it has been necessary from the point of view of the larger public interest to remove such matters as gas and electricity supply, public assistance and health services largely from local government control, the effect on local government should not be regarded without concern. It is essential that the functions of local government should not be thus restricted beyond the minimum that the general interest demands , all that is possible should be done to preserve the vitality of local government and to encourage the individual citizen not only to take a live interest in it, but also to understand it and use the opportunities it affords of influencing policy in matters that directly concern his way of life

Apart from this, the functions of local government have become disproportionate to the finances, organization and areas established for their exercise Frequently, local authorities are either too small to finance the services they provide, or should provide, or too large to manage efficiently the services they finance Moreover, while Mr. Attlee's Government declined to give the Local Government Boundary Commission which it appointed in 1946 adequate instructions, that Government could neither accept the tentative policy suggested by the Commission nor formulate one of its own. Nor has Sir Winston Churchill's Government either formulated a policy or taken any action

When Minister of Housing and Local Government, Mr Harold Macmillan promised to promote any reforms the local authority associations succeeded in agreeing to recommend, and on March 26 expressed a hope that he would present some measure of local government reform during the present Parliament. Meanwhile, the Government has continued the unhappy practice of placing further responsibilities on local government authorities without providing them with the resources to match their responsibilities. It has become manifest that in the matter of national parks, for example, such neglect promises to defeat the whole purpose of the enactment of Parliament , recently the specific proposal has been canvassed that the National Land Fund should be used for national park purposes, at least to the extent of meeting the cost of preserving amenity The Peak Park Planning Board, for example, is seeking the support of the National Parks Commission in pressing for legislation to such an end.

Local government opinion is unanimous that financial reform is even more pressing than structural change, and there is no lack of recognition of the importance of remoulding local government so as to revitalize it. The remoteness of some local government services and the uneconomic character of others may well be due less to the fact that many local government areas bear little relation to real communities, than to the failure to distinguish in status, for the basic local government units, between the extremes of the minor district or borough and the major 'all-purpose' county borough. Apart from this, the services which most closely concern the public and where the local touch can contribute most, such as the social and personal services, like education, maternity, child welfare and other preventive health services, and the care of children and the aged, have been removed from the county districts. Where the local aspects of local government are of most importance, local government has virtually ceased to function.

Unless this is corrected, the real vigour of local government and its roots in the community will be endangered, and thereby parliamentary democracy itself. That was one common theme in the addresses which Mr Attlee and the Archbishop of York delivered at the triennial conference of parish councillors on September 23. Both stressed the value of the small unit in local government, and the dangers attending excessive centralization. Mr Attlee was concerned lest the increasing size of our local government and national units makes our democracy too remote from the people. Dr Cyril Garbett urged that in spite of limited statutory powers, the parish councils could create a strong and healthy public opinion in every parish, and that their freedom of discussion and independence constituted real obstacles against the encroachments of central authority.

Mr Attlee favoured the system of several tiers in local government, rather than bringing such government into the hands of one competent body. This was essentially the solution of the Boundary Commission, which suggested the creation of an intermediate class of 'most-purpose' authority suitable for the bulk of middle-sized and larger towns, irrespective of their present purpose. The 'most-purpose' authority would be large enough for autonomous control of all but the most specialized social services, and would admit extra-local jurisdiction only for impersonal functions requiring wide areas, such as police, fire, ambulance services, public utilities, technical education and major planning work.

What needs to be remembered is that efficiency is not the sole test of local government or the reason for desiring reform. The educational aspect of local government is no less important now than when Mill wrote in the middle of the past century. Indeed, while from the point of view of efficiency, unified administration of large regions is probably more satisfactory than that of a single county was formerly, the educational function of local government is of increasing importance, and any reform of local government should be as much concerned to promote that function as to secure efficient administration.

If local government is in fact to provide the mea by which local groups can manage their own affa and feel that they can influence effectively some the policies that determine their daily welfare, a at the same time provide the training ground f those wishing to enter public life, local governme must not only be local: it must retain and devel functions sufficiently important for it to attract t services of people interested in public affairs. must offer, for example, to the technical or pr fessional man the opportunity of contributi something as a citizen to the course of public affair

Unfortunately, this aspect appears largely to overlooked in the proposals for reform which hav hitherto been canvassed, and the difficulty obtaining unprejudiced candidates of high qualit for local government is also seriously increased b the growing tendency to bring party politics int local government and even into technical question The Association of Municipal Corporations has r affirmed its devotion to the one-tier form of loc authority (the all-purpose county borough), con demned the proposals for the reorganization of loc government issued by associations of county, urba and rural district and parish councils, and asked th Minister of Housing and Local Government t prepare a plan of his own. There appears to be n hope of agreement between the various association as to the one-tier or two-tier, let alone the three-tie systems; but that breakdown does at least aver the danger of a compromise which would disregar the public need and the ultimate purpose of loca government. Mr Harold Macmillan indicated i March that the Government had already done a lo of preliminary work, and the fact that the disput over local government cuts right across party line gives his successor, Mr Duncan Sandys, more scop for manœuvre.

Mr Sandys promised on November 16 to make statement shortly about the Government's intentions and he indicated in reply to a further question tha if legislation was proposed there would be a Whit Paper. It would appear, in fact, that the Ministe now proposes to do what the boroughs have urged to set down in a White Paper the broad principle which the Government has made up its mind t follow, and the discussions which he is having with representatives of local authorities will enabl him to recommend a definite course to be followed The absence of any reference to local government reform from the Queen's speech on November 30, however, suggests that the Government has no intention of introducing legislation dealing with this question during the present session of Parliament.

Pending Mr Sandys's promised statement, there is thus no clear evidence that either major political party is prepared to spare the Parliamentary time and to court the unpopularity that is bound to attend the attempt to deal boldly with local government reform. Meanwhile, although all parties and critics agree that the present system is anomalous and inadequate, and although divisions of opinion cut right across party lines, the burden on central government remains; and at the local end interest dwindles and efficiency diminishes In such a position it is essential for the public, irrespective of party, to urge on whatever minister may be responsible for local government the vital importance of early and firm action to stimulate the renaissance of effective and democratic local government

Local authorities, it should be remembered, have the virtues and vices of all representative bodies , they are part of the method by which people govern themselves, and by which those specially qualified can put their knowledge and skill at the service of the community They encourage and develop responsible citizenship, and their strength is a safeguard against the capture of central government by a would-be dictator They are in touch, moreover, with the circumstances, feelings and needs of their areas, and efficiency in local government would be dearly bought if it destroyed local variety, initiative and responsiveness, and above all the sense of responsibility of the authority to the local electorate

The principles which should determine the attitude of the central government towards local government were well set forth by D N Chester in his book published three years ago dealing with their financial and administrative relations Local government cannot retain vitality unless Parliament and Whitehall trust the local authorities, in the absence of very good reasons to the contrary Minute supervision is incompatible with a sense of responsibility in the supervised it is also expensive in man-power and wasteful Moreover, variety in local action and policy has strength and meaning Variety is a consequence of local independence, of adaptation to differing local views and conditions, and of freedom to experiment , and it is from this point of view that the introduction of party politics into local government may be regretted We cannot have local self-government with complete uniformity or the rigidity of a party caucus Nor need all local authorities be treated alike It is neither good administration nor good democracy to make no discrimination between the varying size and efficiency of existing or future local government units

Of the possibilities open to Mr Sandys or his successor as Minister of Housing and Local Government, the solution recommended by the Local Government Boundary Commission probably offers the best prospect of acceptance The amalgamation of a few counties and the reduction of the number of county boroughs would indeed meet with some objections , but they would be largely discounted by the wide range of functions given to the medium-sized towns and by giving to the counties a few large-scale services Some form of regional authority would, however, be required to provide for the large conurbations such as London, Birmingham, Manchester, Liverpool, Leeds and Newcastle, which now account for some forty per cent of the whole population, and where such services as main roads, open spaces, fire services and water supply can only be planned on a regional basis With the welding of minor authorities into units big enough to resume some of their lost powers, such as those in the social services, and yet at the same time small enough to possess the personal touch and the local knowledge which are indispensable in welfare work—and especially in that among old people—such measures offer a reasonable prospect not merely of establishing reasonable relations between local government and the central authority but also in re-invigorating local authority In this way the attitude of the electorate may be transformed , when local government is able to offer more scope and thus to attract councillors of higher quality, it should have resources adequate for the efficient discharge of its functions, so that it can offer a career with sufficient prospects to attract and retain the services of officers of the highest quality

THE RESISTANCE TO EVOLUTIONARY CHANGE

Genetic Homeostasis

By Prof I Michael Lerner Pp vii+134+3 plates (Edinburgh and London Oliver and Boyd, Ltd , 1954) 12*s* 6*d* net

THE great advances in evolutionary theories which followed the restatement of the principle of natural selection in Mendelian terms can by now be considered classical A new phase of progress is, however, already under way, and to this Prof I M Lerner makes a stimulating contribution in his new book

As he points out, "older evolutionary theories have tended to consider Mendelian populations as relatively uniform, with reserves of variability carried as recessive mutants at individually low frequencies" But more recently "the evidence on concealed variability in natural and domestic populations compels us to view Mendelian populations as being exceedingly heterogeneous aggregates of largely heterozygous genotypes" In fact, we have now come to define the natural sub-units of a widespread species, not in terms of local races of supposedly uniform genetic constitution, but rather as suggested by Dobzhansky, who describes a "Mendelian population" as "a reproductive community of sexual and cross-fertilised individuals which share a common gene pool" This common stock of genes, which is passed around from individual to individual during sexual reproduction, is considered to contain several different allelomorphs at many or most of the possible loci, so that each individual will be multiply heterozygous Most of the allelomorphs, of course, will produce much slighter developmental effects than those commonly used in laboratory work If by selection we concentrate the genes acting in a certain direction, and produce a sub-population which differs from the original one by greater development of some character we are interested in (such as a higher milk yield or production of eggs), we almost invariably find that the sub-population has simultaneously become less fit, and would be eliminated by natural selection It is to this phenomenon that the name 'genetic homeostasis' has been given, implying that if, in a population at equilibrium under natural selection, action is taken (for example, artificial selection) which results in a change in gene frequencies, natural selective processes will be set in motion which tend to restore the gene frequencies to their original value

The main gist of Lerner's book is a thesis as to the mechanism of these homeostatic processes One pillar of his argument is the recognition that the effect which a change of gene frequencies has on the incidence of natural selection will depend on the way the genes affect the development of the individual organisms concerned It is refreshing to find a population geneticist who realizes that he cannot avoid talking embryology and who does his best to do so in a sophisticated rather than an elementary fashion Lerner's next step is to point out that, in organisms which have been submitted to natural selection, development is to some extent canalized or 'buffered' , that is, it involves feed-back mechanisms of such a kind that the normal optimum adult form tends to be produced under a fairly wide range of conditions Then follows the really new point which he is making He argues that this buffering is dependent on heterozygosity, and that when we select for a particular character and thus produce a sub-population with changed gene frequencies, the concomitant lowering of fitness arises because the selection inevitably produces a greater degree of homozygosity, which renders the individuals of the population more at the mercy of chance circumstances during their growth

There is a certain amount of evidence from several different organisms that cross-bred, heterozygous individuals are better buffered in their development than inbred, relatively homozygous ones , and again, there is some evidence, though not very much, that the more efficient buffering is associated with a greater fitness in the face of natural selection The evidence does not, however, all tend in one direction , for example, hybrids between local races of *Drosophila* from widely separate localities are less fit than cross-bred individuals from a single population, though they might well be expected to be more heterozygous It seems probable, indeed, that we have to think of any one natural population as possessing what Dobzhansky has called a "co-adapted gene complex" , that is, a collection of particular allelomorphs which have been selected because they interact together to give rise to well-buffered development The most far-reaching arguments in Lerner's book, however, rather discount the importance of the specific nature of the genes which are heterozygous or homozygous He safeguards himself at various places by stating that the particular character of the genes concerned is, of course, of importance , but he devotes a large part of his exposition to urging that the efficiency of developmental buffering (and therefore the fitness) may depend on the degree of heterozygosity as such, without reference to which loci are heterozygous

In my view this is throwing the baby (the general principle of the specificity of gene action) out with the bath water (the importance of single major genes as opposed to large numbers of less-effective gene differences) One can, for example, easily obtain populations each of which has its buffering lowered in respect of a particular developmental sequel to a specific environmental stimulus, and one can show that the differences between the populations are genetically determined Whether this effect on the buffering is due to homozygosity or not, it must at any rate be brought about by specifically different genes in the different populations Nevertheless, although one feels that Lerner's thesis does not contain the whole truth, it may contain a part of it, and at least point toward some theoretical developments which have not yet been fully worked out We still understand so little about the mechanisms involved in developmental buffering that one would hesitate to deny that Lerner may be correct in suggesting that there is some non-specific effect of homozygosity on that process, even though one retains the belief that there are also specific effects which he seems to pass over rather too lightly In any event, one can only be grateful for such a clear and stimulating discussion of topics which are in the very forefront of scientific advance in one of the most fundamental of all biological fields

C H Waddington

ST. MARY'S HOSPITAL MEDICAL SCHOOL

The History of St Mary's Hospital Medical School
By Sir Zachary Cope Pp x+257+26 plates (London William Heinemann, Ltd , 1954) 25*s.* net

THAT the biography of a medical school reflects, in large part, the history of medical education is well illustrated by the story of St Mary's Hospital Medical School, which last year celebrated its centenary The second youngest of the London undergraduate medical schools and a mere babe compared with some of its associates, its trials and tribulations in the past century have to some extent been a common experience , yet it has, as medical schools do, developed its own personality, and some episodes in its history have been unique It is, for example, the only London medical school which started from a definite plan to build a teaching hospital and medical school at the same time The Paddington area had developed enormously in the first half of the nineteenth century, due mainly to the Grand Junction Canal with its Paddington wharves and to the building of the Great Western Railway terminus For this rapidly growing population there was no hospital nearer than St George's across Hyde Park to the south and the Middlesex Hospital to the east It happened that, at the time of the project for founding a new hospital, Mr Samuel Lane was running a successful private medical school near St George's, but had not achieved an ambition to be appointed on the staff of that Hospital He and some of his St George's supporters were elected to the committee charged with building the new hospital, and no doubt it was this group that advocated the founding of a medical school as part of the plan Indeed, before the hospital could be recognized as a suitable place for clinical instruction of medical students, one of the licensing bodies, the Society of Apothecaries, required that it should have both a resident apothecary and an attached medical school Accordingly, the building for the new School, accommodating some three hundred students and costing £2,500–£3,000, was completed within four months of its commencement in the summer of 1854 It was an inconspicuous building—"hidden away in the space between the hospital, the Great Western terminus, and the canal, it was as difficult to find as Meckel's ganglion".

As the new Hospital grew in piecemeal fashion, the Medical School took roots under a succession of deans, including Ernest Hart, for many years editor of the *British Medical Journal* , W B. Cheadle, who persuaded the Hospital to allocate its share of the School profits for the foundation of entrance scholarships and who, with other St Mary's men, helped to establish the first medical school for women , George Field, who founded a residential college and under whose attractive personality the School at first lourished but later relapsed into the doldrums , and H. A Caley, during whose tenure two important ppointments were made—B E Matthews became School secretary in 1900 and held the post with ncreasing responsibility and quiet efficiency for early fifty years, and Almroth Wright was appointed o the dual lectureship in pathology and bacteriology n 1902, his genius soon imparting a new spirit of nthusiasm to both teaching and research In the ext year, St Mary's unfortunately lost another rilliant teacher and investigator in Augustus Waller, who for nearly twenty years had taught physiology n the School and was the father of the electrocardiograph So, after short terms of office by Clayton Greene and Sir John Broadbent, we come to he man whom Sir Zachary Cope rightly calls "the Great Dean"—Dr. Charles Wilson (now Lord Moran), ater to become a famous president of the Royal College of Physicians and medical adviser to Sir Winston Churchill, but among St Mary's men to be emembered always as the architect who over a quarter-century dreamed and planned and brought nto being the new St Mary's Hospital Medical School After a searing and maturing experience as a regimental medical officer during the First World War, Dr Wilson was appointed as assistant physician o St Mary's Hospital in 1919 and became dean in he following year The outlook for the School at hat time was ominous, particularly as the new dean ad been told by members of the University Grants Committee that St. Mary's had no future as an ndergraduate medical school But Wilson had great qualities, among them the capacity for quick and letermined action The Royal Commission on Undergraduate Education had lately recommended he establishment of full-time clinical appointments, nd although there was no hope of financial support rom the University Grants Committee for such a venture at St Mary's, the dean persuaded two outstanding members of the clinical staff, Dr Wilfrid Harris and Mr Clayton Greene, to become part-time irectors of new medical and surgical units This old step soon had its reward, for the University of London in 1921 agreed to undertake three-quarters f the cost of two clinical units in medicine and urgery, and Dr F Langmead and Mr C. A. Pannett were respectively appointed to be the first full-time rofessors of medicine and surgery

The next great problem was to find bigger and etter premises Here again Dr Wilson so impressed wo rich philanthropists, Lord Revelstoke and Lord Beaverbrook, that between them they contributed early £90,000 which, with a grant from the University of London, allowed the new Medical School to be pened by King George V in 1933 Another great riumph for the dean was the acquisition of the very ne athletic grounds at Teddington, helped again by he munificence of Lord Beaverbrook Meanwhile, Dr Wilson, with his remarkable judgment of character, was steadily improving the quality of the new ntrants to the Medical School By direct contacts with headmasters and college tutors and by personal nterviews with the applicants, he was able to attract o the School a steady influx of young men of high ntelligence, strong character and athletic ability, so hat, in 1934, St. Mary's became the first London School to accept only those students intending to work for a university degree. The social activities f the School also prospered, and by 1945, after wenty-five years tenure of the office of dean, Lord Moran could justly claim that the School had been both materially and spiritually re-created

This documentary study of a medical school is supplemented by chapters on the development of medical specialization in both pre-clinical and clinical education and on the remarkable story of the band of famous men whom Sir Almroth Wright attracted around him in the Inoculation Department (later re-christened the Wright–Fleming Institute), together with biographical sketches of the School's seven Fellows of the Royal Society and of a galaxy of outstanding men (and one woman) who spent some part of their lives in the service of St. Mary's Hospital and its Medical School The author, himself associated with the School for more than half a century, will be gratefully acclaimed by a much wider public than the 'old boys' of St. Mary's for this graphic contribution to the history of medical education.

R CRUICKSHANK

EXPERIMENTAL NUCLEAR PHYSICS

Experimental Nuclear Physics

Edited by E Segrè. Vol 1. Contributors H Staub, H Bethe and J Ashkin, N F Ramsey, K. T. Bainbridge Pp ix+789. 120s net. Vol 2 Contributors P Morrison, B. T Feld Pp. viii+600 96s. net (New York John Wiley and Sons, Inc., London Chapman and Hall, Ltd , 1953)

THE publication of the two-volume review of "Experimental Nuclear Physics", edited by E. Segrè, provides a much-needed summary of development in nuclear physics to take the place of Prof Hans Bethe's 1937 review of nuclear physics, which at that time rendered a similar service

The review is provided by a distinguished list of authors Prof Hans Staub writes on the development of methods of detecting nuclear particles. The principles and practice of ionization chambers, proportional counters, Geiger–Muller counters, crystal counters, scintillation counters and Čerenkov counters are described as well as cloud chambers or nuclear emulsions. The associated electronic instruments are similarly dealt with and, in particular, fast counting circuits and coincidence circuits One section is devoted to the detection of neutrons by gaseous detectors, boron trifluoride counters and fission detectors

Prof. Hans Bethe and Dr. Julius Ashkin write on the passage of radiation through matter. The range–energy relations for protons and alpha-particles are brought up to date and extended out to energies of 3 BeV. when protons have a range of 10 km. This illustrates the great development in the range of particle energies now available to experimental nuclear physics The range–energy relations are given not only for air but also for hydrogen and different metals A theoretical discussion of range–energy relation is also given with respect to ionization The penetration of high-energy electrons and gamma-rays through matter is also dealt with exhaustively.

In his article on nuclear moments and statistics, Prof Norman Ramsey gives a theoretical discussion on the interaction of the nucleus with atomic and molecular fields, and this is followed by a description of experimental methods of measuring nuclear moments and statistics The methods of hyperfine structure, band spectra and molecular and atomic beams are well described, and the powerful resonance method for molecular beams is discussed Microwave spectroscopy, which has also proved to be a powerful tool, is described. Finally, details are given of all known experimental results on nuclear moments and spins and their regularities, and the significance is discussed Prof Ramsey also contributes a section on nuclear two-body problems and elements of nuclear structure In this section the experimental evidence for the nature of nuclear forces is discussed Results on proton–proton and proton–neutron scattering are surveyed for energies up to 400 MeV., and an account is given of the theories of scattering and the meson theory of nuclear forces Finally, the author gives a brief description of the theory of nuclear shell structure

Prof. K T Bainbridge contributes a section on charged particle dynamics and optics, relative isotopic abundances of the elements and atomic masses The general theory of mass spectrometers is given, including a comprehensive treatment of the different methods of magnetic focusing Typical mass spectrometers including those of Dempster and Nier and Mattauch are discussed. The section concludes with tables of the relative isotopic abundances of the elements and isotopic masses

A survey is given by Prof P Morrison of the vast amount of experimental work on nuclear reactions which has been carried out during the past decade The theories of nuclear reactions and their relation to nuclear structure are also thoroughly discussed A chapter is devoted to nuclear fission and another to nuclear reactions of high energy Prof B T Feld contributes 380 pages on neutron physics, including a bibliography of sixteen pages The interaction of neutrons of energy from thermal energies up to many millions of volts is discussed Experimental techniques of neutron physics are described, and finally the interaction of neutrons with matter in bulk is dealt with, including a chapter on elementary reactor theory.

These two volumes present an encyclopædic survey of the present state of nuclear physics, and should be in the library of all laboratories working on this subject J D COCKCROFT

RADIOISOTOPE TECHNIQUES IN DIAGNOSIS, THERAPY AND RESEARCH

Radioisotope Techniques

Proceedings of the Isotope Techniques Conference, Oxford, July 1951, sponsored by the Atomic Energy Research Establishment Vol 1 Medical and Physiological Applications Pp vi+466+42 plates (London H M Stationery Office, 1953) 50*s* net

SINCE the construction of the low-energy experimental pile (GLEEP) and its successor (BEPO) at Harwell, the Atomic Energy Research Establishments at Harwell and at Amersham have supplied radioactive isotopes for clinical and research purposes in Great Britain and in many overseas countries These Establishments have become, in consequence, informal clearing-houses for problems and ideas relating to the production, manipulation and application of radioactive isotopes For the steadily increasing number of medical and scientific workers and engineers using radioisotopes, it was therefore highly profitable that senior members of the Establishments should organize a conference on radio isotope techniques in 1951 The conference was held in Oxford and was attended by nearly five hundred representatives of some twenty nations The proceedings of the conference have been published in two volumes, the first and larger of which, dealing with medical and physiological applications, is reviewed here

The proceedings contain seventy-one papers together with the discussions which followed their presentation in conference and deal with a very wide range of techniques and applications The papers are grouped under three main headings therapy and diagnosis , biochemistry and metabolic studies and plant biochemistry Papers grouped under the first heading deal mainly with the use of iodine-131 in the diagnosis and treatment of abnormal thyroid function, and the use of such isotopes as phosphorus-32, cobalt-60, and cerium-144 as beta- and gamma ray sources in irradiation therapy Papers under the second heading deal with the use of radioisotopes in biochemical and physiological research and cover such subjects as the use of 'labelled' proteins in immunochemistry and the determination of sodium and potassium in invertebrate nerve fibres by activation analysis The third and smallest group of papers deals mainly with the uptake and distribution of phosphorus-32 in plants either as fertilizer or as labelled insecticides The discussions were frank and constructive, and in some cases constituted a salutary addendum to the preceding paper

The papers dealing with the medical applications of radioisotopes in diagnosis and therapy suggest that much has yet to be learned about the use of pile-produced radioisotopes for the selective destruction of tumours *in vivo* As a diagnostic aid and also in small doses for the clinical appraisal of metabolic behaviour, radioisotopes appear to be well established with considerable potentialities The papers illustrate clearly that, in biochemical, physiological and agricultural research, radioisotope techniques have constituted a major advance in recent years for example, in the study of precursor–product relations in steady-state systems—an important problem scarcely soluble except by isotope tracer techniques Many useful and novel techniques are described for the location of radioisotopes in large animals, in plants, on paper chromatograms and in histological sections Some of the complications of radioisotope applications also receive attention, such as the difficulties of constructing directional counters, collimating powerful gamma-ray sources and the importance of recognizing radiation effects in labelled fertilizer studies

The standard of the papers is high for a conference of this sort, when sometimes papers are thinly disguised excuses for participation at a conference Surprisingly few typographical errors have been noticed Two papers mysteriously appear in the wrong section (pp 379 and 381), and the title "Chromatographic Techniques" includes a curious range of subjects The proceedings provide a unique review of recent developments in radioisotope applications not to be found in current text-books on the subject Moreover, they provide an indication of future developments, by whom and where, which is of particular value to the radioisotope specialist Although a more recent conference on radioisotope techniques was held in 1954, it seems unlikely to vitiate the value of the published proceedings of the 1951 conference F P W WINTERINGHAM

THE INTERNATIONAL GEOPHYSICAL YEAR, 1957–58

By PROF SYDNEY CHAPMAN, F R S

A DESCRIPTION was given in *Nature* of August 22, 1953, of the inception and progress of the plans for the world-wide enterprise entitled the International Geophysical Year. This is a successor to the two International Polar Years of 1882–83 and 1932–33 It follows the latter after twenty-five years, instead of the fifty that elapsed between the two Polar Years It covers the whole globe instead of being specifically devoted to the polar regions, and its scientific scope is far wider than that of its predecessors They fell near sunspot minimum , the International Geophysical Year will be at or near sunspot maximum, and its duration will be eighteen months, from July 1, 1957, to December 31, 1958

The International Council of Scientific Unions is the official sponsor of the enterprise, which it has adopted for the time being among its 'permanent services' , important financial support for the central organization is afforded also by the United Nations Educational, Scientific and Cultural Organization The Council has appointed a Special Committee to provide the central direction and co-ordination of the efforts of the many nations participating in the International Geophysical Year The Committee—known by the initials of its French title as CSAGI (Comité Spécial de l'Année Géophysique Internationale)—is constituted on a functional, not national, basis, being composed as follows of persons representing the international scientific bodies indicated (International Council) L V Berkner (vice-chairman), S Chapman (chairman), E Herbays and M Nicolet (general secretary , at 3 Avenue Circulaire, Uccle, Belgium) , (International Astronomical Union) A. Danjon and Sir Harold Spencer Jones, (International Union of Geodesy and Geophysics) J Coulomb, G. Laclavère, V Laursen and P Tardi , (International Union for Scientific Radio) W J. G Beynon and M Boella , (International Geographical Union) J M. Wordie, (International Union of Pure and Applied Physics) J A Simpson and S Vallarta , (World Meteorological Organization) J. Van Mieghem and T E W Schumann The Joint Commissions on Solar and Terrestrial Relationships, and on the Ionosphere, of the International Council are linked with the Special Committee through its members Nicolet and Beynon

The Special Committee held its first full meeting in Brussels in July 1953, together with some representatives of the national committees formed at the invitation of the International Council through Colonel E Herbays, the provisional secretary and convenor of the Committee, at its preliminary meeting in October 1952 At Brussels in 1953 the Special Committee considered reports and proposals from twenty-one national committees and from the Unions of Geodesy and Geophysics and of Astronomy, and from the World Meteorological Organization , these documents, and the agenda for the meeting, were published in the IUGG News Letter in its quarterly issue (Vol 2, Part 3) of July 1953. The proceedings, provisional programme and resolutions of the Special Committee, together with four additional national reports, appeared in the October 1953 issue of the News Letter This completed the first stage of the plans for the International Geophysical Year

The Special Committee held its second full meeting at Rome during September 30–October 4, 1954, in the palace (and by the courtesy) of the Italian National Research Council Between this and the 1953 meeting the national committees reviewed and developed their plans for the International Geophysical Year, in order to present revised reports to the Rome meeting The general secretary issued invitations to countries that had not yet decided to take part in the International Geophysical Year to participate in the enterprise, and to prepare plans in the light of the provisional programme drawn up in 1953 The associated international bodies represented on the Special Committee were also requested to give further consideration to the programme and plans They and the adhering nations were requested to send members to attend the Rome meeting to assist the Special Committee in its discussions. During the summer of 1954 meetings were held by the International Unions of Pure and Applied Physics, of Scientific Radio, and of Geodesy and Geophysics, as also by the Joint Commissions on the Ionosphere and on Radio Meteorology , at all these, active consideration was given to the plans for the International Geophysical Year

These intensive preparations bore good fruit Those attending the Rome meeting of the Special Committee numbered slightly more than a hundred, drawn from about thirty nations Almost all those present took an active part in the discussions of one or other of the many working groups which considered the various branches of the programme The documents resulting from the arduous labours of the first three days of the meetings (Thursday – Saturday) were prepared by the secretariat during the Sunday recess, and presented to a plenary meeting on October 4

At the outset of the meeting, the general secretary was able to report that thirty-six nations had formed national committees, and that the formation of others was pending During the meeting the officers were informed by the Embassy of the U S S R in Rome that the Academy of Sciences of the U S S R had responded to the invitations sent to it to participate in the International Geophysical Year, and had appointed a national committee for the purpose, under the presidency of Academician Gemburzev, director of the Geophysical Institute of the Academy , also that a U S S R delegation of eleven members, who as guests had attended the General Assembly of the International Union of Geodesy and Geophysics held in Rome during September 1954, had been appointed also to attend the meeting of the Special Committee Members of the delegation indicated that the U.S S R. Academy of Sciences would co-operate also in encouraging other nations to participate in the International Geophysical Year.

The principles so far tacitly applied in the selection of items for the programme of the International Geophysical Year were explicitly formulated at Rome as follows the first priority is given to problems requiring concurrent synoptic observations at many places on the globe, involving co-ordinated effort by many nations , second come geophysical problems the solution of which will be aided by the availability of the results of synoptic or other concentrated geophysical work undertaken during the Year , a third principle is that where the main programme involves the occupation of stations in regions of the earth to which comparatively little geophysical effort has been devoted, advantage should be taken of the opportunity to make observations also of other major geophysical phenomena, for example, earthquakes , fourthly, geodetic and other observations will be made of slowly varying geophysical phenomena, for comparison with similar future observations at later epochs

During the International Geophysical Year the most modern types of observation of many kinds, for example, meteorological, ionospheric, magnetic and auroral, will be more widespread over the globe, and made with greater frequency, than ever before. But even during this period there will be intervals of specially intensive observation. Definite plans have been formulated for the choice of these intervals, subject to final adoption by the Special Committee at its meeting in 1955 The intervals include three Regular World Days each month, of which two will be at new moon and one near the quarter moon , these have now been designated—they include days of predictable events such as solar eclipses and meteor showers. In the field of meteorology there will be six World Meteorological Intervals of ten days each, one in each period of three months, near equinox or solstice , each such interval includes the three Regular World Days during the month in which it occurs.

There are some geophysical phenomena, however, the occurrence of which cannot yet be predicted with much probability (if at all) more than a few days ahead, namely, magnetic and ionospheric storms and auroræ, which are dependent on solar flares and other exceptional events on the sun. Great magnetic storms are associated with the appearance of auroræ visible from regions far outside their usual limits—perhaps the most outstanding case was that of February 4, 1872, when a brilliant aurora was seen from the greater part of the globe, including Bombay and Aden It is hoped that if any such events occur during the Geophysical Year—and this may be expected—they will be properly observed, for the first time in geophysical history. Careful plans are being made to achieve this, and to enable ionospheric and magnetic observatories to give to such phenomena the special attention that is their due To this end there will be close co-operation between the solar observatories that will keep a close and (it is hoped) continuous watch on the sun, and the organizations that now make predictions of ionospheric and magnetic conditions , when the state of the sun indicates the likelihood of geophysical disturbance a few days ahead, a World Alert-Period will be designated, and notified the world over by radio and other means of communication When the continuing developments on the sun render it suitable, a Special World Interval will be declared about 12 hr in advance, to continue until terminated by the predicting agencies. The agencies will also give world-wide notice of the co mencement of great geophysical disturbances th may occur without having been foreseen. Throu these procedures it is hoped that detailed observatio of the morphology of these disturbances will possible, and that even down to low latitud preparations for proper auroral observation will made It is hoped that, in co-operation with centr elsewhere, the U.S. Central Radio Propagati Laboratory will undertake to designate and noti these special periods

The principal fields of geophysical science to cultivated during 1957–58 will be meteorology, ion spheric physics, geomagnetism, the aurora and a glow, and cosmic rays , astronomical institutio will give essential assistance through solar observati and their geodetic work on determinations of latitud and longitudes. Some effort will also be devoted oceanography, glaciology and seismology An portant programme of rocket observations has be formulated In this work the chief participant w be the United States , but it is hoped that some oth countries will also be able to arrange co-operation rocket studies of the upper atmosphere.

Careful attention was given at the Rome meeti to the geographical distribution of observing statio planned or desirable, in order to detect importa gaps, with the view of seeking means of filling the and also recommending combination or eliminati when unnecessary duplication might occur. Areas which special effort will be devoted are the Arct and Antarctic caps and the tropical zone, togeth with three special meridians, 70–80° W , 10° E a 140° E It appears that only minor changes in t programmes proposed by the various individu nations will suffice to achieve an excellent wor geophysical network

The measure of co-operation envisaged will, executed, make the International Geophysical Ye by far the most extensive and important inte national scientific enterprise yet accomplished

Gradually public knowledge of the plans for t International Geophysical Year is being spread newspaper and magazine articles in many countri The U S. Congress has made generous financial pr vision for the preliminary stages of American pa ticipation, which will be under the ægis of t National Scientific Foundation. President Eise hower, in a public statement, has warmly endors this far-reaching effort as one that will "ve materially strengthen our bonds with the ma co-operating nations and make a constructive co tribution to the solution of mutual problems". H Holiness Pope Pius XII has likewise commended t enterprise as one likely to contribute to a mo peaceful and co-operative attitude among t peoples of the world, as well as to their materi betterment

The countries participating in the Internation Geophysical Year, in alphabetical order according the English versions of the names of the countri are as follow (up to October 1, 1954) Argentin Australia, Austria, Belgium, Brazil, Britain, Canad Czechoslovakia, Denmark, Finland, France, Germa (Eastern), Germany (Western), Greece, Hollan Iceland, India, Ireland (Eire), Israel, Italy, Japa Mexico, Morocco, New Zealand, Norway, Pakista Peru, Philippines, Russia (U S.S R), South Afric Spain, Sweden, Switzerland, Tunis, United Stat (U S A), Yugoslavia

PRECISION ELECTRICAL MEASUREMENTS

A SYMPOSIUM having as its general theme the techniques of precision electrical measurement was held at the National Physical Laboratory during November 17–20. Twenty-six papers were read and discussed, the authors being drawn from a particularly wide field, including not only some of the principal electrical laboratories in Britain but also members of the national laboratories of Australia, South Africa and the United States, and well-known workers from Germany, Holland and Sweden. In opening the proceedings, Dr. P. Dunsheath remarked that precision is evidently used as a relative term, for the errors recognized in, say, some of the magnetic and high-voltage techniques would fill those dealing with more manageable techniques with horror. Indeed, the subsequent discussion showed that mere statements of percentage accuracy are seldom of much interest; the important points are those which ensure that an experiment does in fact satisfy the conditions postulated in asserting that the quantity measured is such-and-such.

The symposium was divided into five sessions which dealt successively with subjects that form substantial items in the work of the Electricity Division of the National Physical Laboratory and that bear more or less directly on industry. The first session was devoted to the techniques applicable to electric fields and dielectrics; the second to magnetic fields and associated materials; the third dealt with electrotechnical measurements; the fourth with standard techniques for the high-voltage laboratory; and the last with the techniques of impulse-testing.

Perhaps the most outstanding feature of the techniques for the measurement of dielectric constant and power loss discussed in the first session was the range of frequency covered. Various aspects of the standard bridge and resonance techniques were introduced by Dr. L. Hartshorn and E. Rushton and J. V. L. Parry, of the National Physical Laboratory. Dr. M. Gevers, of the Philips Research Laboratories at Eindhoven, emphasized the versatility of standing-wave methods for the microwave range, and it appears that these are superior to cavity resonator methods for materials of high loss, though the cavity has the advantage for low-loss materials. D. Woods, of the Ministry of Supply, showed that a bridge of the twin-*T* type can be constructed to give high precision at frequencies up to 300 Mc./s. At such frequencies, however, a massive block of brass used as the junction of two or more arms of the bridge is no longer an equipotential; it must be represented on the bridge diagram not as a mere junction point but as a network of small inductances. On paper, therefore, the bridge network opens out formidably, while the concrete reality shrinks to a closely interlocked group of brass blocks and cylinders the construction of which calls for mechanical work of very high precision. This indeed is a limitation of the technique, though its value for the particular purpose of calibrating standard coaxial components is obvious.

Considerable interest was also shown in techniques applicable to dielectric behaviour at extremely low frequencies. Dr. G. Mole and D. C. G. Smith, of the Electrical Research Association, described an a.c. bridge which is conveniently workable at frequencies down to 0.05 c./s., but the discussion showed that d.c. techniques are usually preferred for general work in this region, if only because, as C. G. Garton mentioned, time constants of the order of 50 hr. have been observed, and for periodic times of this order a.c. methods become quite impracticable.

Much of the discussion in the second session was concerned with various forms of permeameter used for determining the characteristics of industrial materials. C. E. Webb, of the National Physical Laboratory, dealt with standard methods for the delineation of magnetization curves. The discussion showed that the ballistic method is almost universally employed for the curves which serve as a basis for industrial design, and the discussion dealt largely with fine detail. Dr. M. McCaig, of the Permanent Magnet Association, stressed the difficulty of winding magnetic potentiometers with adequate uniformity and described a test that had revealed unsuspected errors in all such coils however carefully they had been wound. Prof. J. Greig and others mentioned the growing importance of methods for integrating and recording slow changes of flux and thus delineating individual cycles of magnetization, as a supplement to the ordinary curve for the steady cyclic condition that is determined point by point by the ballistic method; the two are clearly not necessarily the same and the differences are likely to be instructive. A paper by T. M. Palmer, of the Australian National Standards Laboratory, described a magnetometer in which a saturable core consisting of a short length of mumetal wire is used as a probe. The probe is small enough to serve as a null-detector for the measurement of *H* in a permeameter and it therefore offers an interesting alternative to search-coil methods; but its advantages have so far only been established for measurements of the earth's field and the like.

Methods for use at communication frequencies were described by A. C. Lynch, of the Post Office Engineering Research Station, and by P. H. Haas, of the U.S. National Bureau of Standards. Such methods depend on measurements of the inductance and equivalent resistance of toroidal cores provided with a suitable winding, the contribution of the winding alone being calculated or measured separately after removal of the core. The nature of the winding is an important factor; Mr. Haas places the core in a metal chamber which when closed by a cap forms a single short-circuited secondary turn; Mr. Lynch prefers a wire winding of three discrete turns; and Dr. C. M. van der Burgt, of the Philips Laboratories, showed an alternative scheme, by which a silver winding can be opened and closed for the insertion of the toroidal core, without introducing any uncertainty into the resistance of the winding, which is an extremely important factor.

A paper by R. L. Driscoll, of the U.S. National Bureau of Standards, described the determination at that laboratory of the magnetic moment of the proton (or more strictly its gyromagnetic ratio) by means of nuclear resonance. This brought microwave techniques and frequency measurement into the picture, and introduced the idea that the proton may conceivably serve as a magnetic standard accessible to everybody who can command the technique. The resonance frequency being determined only by the product of a constant characteristic of the proton and the field strength, it becomes possible to measure magnetic fields by observations of a frequency of resonance in water or any suitable material rich in protons used as a probe At the National Bureau of Standards the field is actually measured in present-day units by weighing the force on straight conductors of accurately determined length suspended in it The method is no doubt the best available for strong fields For weaker fields it is probable that greater accuracy could be obtained by producing the field by passing a measured current through a primary standard inductor The use of such an arrangement as a basis for magnetic measurements, and in particular for the calibration of search coils, was discussed in a paper by G H Rayner, of the National Physical Laboratory

The electrotechnical session began with the recognition that the accuracy of all measurements depends on the constancy of the quantities involved Two aspects of the underlying problem were discussed, namely, the constancy of a c generators and that of the alloys used for the construction of standard resistors It became clear that electronically stabilized supplies are coming into general use in standards laboratories, and the system described by B V. Hamon, of the Australian National Standards Laboratory, provided a good example , two 3-phase, 12 kVA. alternators have automatic control of both frequency and voltage to about 0 01 per cent at any setting in the working range C Petersen, of the U S National Bureau of Standards, reviewed the work on resistors, and great interest was shown in the subject It became evident that an alloy of exceptionally high resistivity and adequate stability has been sought in vain by many, that manganin still holds its place for stability, with constantan as an alternative that is almost indispensable for a c work, and that modified nickel–chromium alloys show promise of higher resistivity with stability The remaining papers centred around the problem of the d c to a c transfer standard In theory no standard is necessary , instantaneous values are measurable by direct reference to d c. standards, but practice is mainly concerned with steady-state values, and the accuracy required is much greater than can be obtained for instantaneous values Hence the importance of the stabilized supply mentioned earlier, and the transfer standard which indicates with precision either d c or stationary root mean square values Examples of the three types now in use were discussed a dynamometer wattmeter constructed by Dr O Brune and J W Whittaker at the National Physical Laboratory, South Africa , thermal instruments used as ammeters and voltmeters at the U S National Bureau of Standards described in a paper by F L Hermach , and the electrostatic wattmeter used at the National Physical Laboratory and described by Dr A H. M Arnold with particular reference to work at audio-frequencies

On proceeding to higher voltages, the same considerations apply with the additional complications that clearances must be made larger to avoid breakdown so that the equipment tends to become excessively bulky, resistors of extremely high value become necessary to avoid excessive power dissipation and transients as well as steady-state values are often required The compressed gas capacitor, discussed by Dr A Keller, of Hartmann and Braun A G , Germany, well illustrates one answer to the problem of keeping down the bulk of the equipment Single units containing carbon dioxide at 14 atmospheres pressure have now been made to withstand an operating voltage of 900 kV (r m s), with a capacitance of 65 pF They serve as standards fo the measurement of dielectric loss at high voltage G W Bowdler, of the National Physical Laboratory discussed methods for the measurement of hig voltages in steady-state conditions, especially th construction of resistors of high value, and potentia dividers, and the use of the attracted disk electrostatic voltmeter, which with compressed gas insulation has been used up to 600 kV. (peak). P R Howard, of the National Physical Laboratory, deal with the measurement of transients It is, of course the cathode-ray oscillograph that has made suc measurements possible, but accuracy depends largel on the proper control and assessment of stra capacitance and inductance in the auxiliary equipment of voltage divider and cables between th instrument and the point of the system unde investigation F S Edwards, of the Metropolitan Vickers Electrical Co , Ltd , discussed the sphere-ga as a peak voltmeter Most speakers saw somethin incongruous in the basing of a standard on anythin so erratic and violent as an electric spark , but th fact that standard calibrations for the sphere-ga have been issued in Britain, the United States an Germany is evidence of its practical importance fo the measurement of very high voltages and of th need for a knowledge of the ways of minimizing th errors and estimating their magnitude

The final session was devoted to a discussion o impulse tests on high-voltage equipment At first sight the problems are somewhat remote from precision measurement The objective is a proof o the ability of a transformer, cable or other insulated system to withstand surges of voltage such as are liable to arise in practice from lightning strokes o switching operations Surges of suitable severity must be generated, applied at specified points, and the currents or voltages at key points must then be examined for any departure from normal behaviou such as could arise from partial failure The whol problem is of such intricacy, including as it does th recognition and interpretation of special features i transients in complicated systems of inductance capacitance, etc , that the techniques are far les standardized than are those of a measurement However, the discussion showed that the technique have much in common with those of measurement The distribution of transients within a comple network, for example, is determined by facto exactly similar to those in a high-frequency bridge The problem of the common junction point in M Woods's bridge discussed in the first session has it counterpart in the common 'earth' of an impulse testing system, and the proper location of eart capacitance and residual inductance provides th solution in both cases The details, however, def summary treatment W G Standring, of th National Physical Laboratory, presented a genera survey of the problem , N Hylten-Cavallius, o A S E A , Sweden, an account of the design an construction of surge generators , G H Hickling, o C A Parsons and Co , Ltd , J Neuve-Eglise, o Electricité de France, and P G Provoost, o K E M A. Laboratories, Holland, each recorde experience of the detection of faults in transformers and B Salvage, of W T Henley's Telegraph Work Co , Ltd , discussed the corresponding problem fo cables and their accessories

The complete proceedings will be published as soo as practicable and will be obtainable from H M Stationery Office L HARTSHORN

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

OPEN DAY AT THE BATTERSEA LABORATORIES

THE importance of both theoretical and applied research to the maintenance of Britain's industrial position is being increasingly recognized to-day, and the iron and steel industry, which can fairly be described as the core of the entire British industrial complex, is particularly conscious of the vital bearing of research on economic efficiency. The extensive facilities of many industrial firms were further reinforced by the formation in 1945 of the British Iron and Steel Research Association. Besides laboratories at Sheffield, Normanby and Swansea, where practical problems can be tackled in the heart of the appropriate industrial centre, much theoretical and supporting work is carried out by the London laboratories of the Association, notably those at Battersea. Something of this work, chiefly that of the Plant Engineering Division and the Physics and Chemistry Departments, was on view on November 18 and 19, when there were open days at the laboratories. Besides fundamental research into their own special subjects, the groups concerned support the general work of the Association's other Divisions. The short notes which follow give a brief survey of a selection of these projects illustrated at Battersea.

Plant Engineering. The Electrical Engineering Section of the Plant Engineering Division has recently been studying the relation of the operator to his working environment in an attempt to match the control to his abilities, thus achieving a higher working efficiency for the manually controlled machine. The work arose out of earlier crane studies which showed that controls were often badly arranged, difficult to manipulate quickly, and lacking in realism—that is, handles did not move in the direction of motion. Re-design of the master controller itself allowed a much more compact grouping of the controls around the operator, and provision of a work seat designed by Dr. H. Darcus, of the Department of Anatomy, University of Oxford, helped to improve the operator's working conditions. Attention was then turned to the design of the crane cab itself, with the result that visibility was much improved. As a result of this first phase of the work, a series of suggestions were published[1], many of them quantitative, on the design of controllers and control points in steelworks.

In 1953 a Mutual Security Aid grant was obtained to continue and extend this work. Attention has been given to the design of foot controllers, about which little is known, and which have great potential value where several controls have to be operated by one man. Experimental equipment has been designed consisting of one of the new controllers equipped with an adjustable foot-pedal and connected to a motor driving a visible jockey. Several operators were trained to move this jockey via the foot control, so as to make it coincide with a hand-set jockey, and were then given tasks of adjusting the device to different set points for a given period each day. All foot movements were recorded on teleprinter tape, and subsequent analysis has enabled the best position of the foot-pedal pivot, relative to the ankle point, to be determined approximately. This work is being continued, and it is proposed also to compare the relative merits of pivoting and 'push' type foot controllers.

Quite wide divergencies still exist in hand controllers in the angle of movement, spacing of steps, length of handle, force required to operate the handle, and type of handle grip. In an attempt to determine the optimum conditions, a special controller has been made in which these factors can be varied. Here again, the operators' success in controlling a jockey with the hand controller will be measured and will form the criterion by which the quality of the control will be assessed.

Chemistry Department. The presence of nitrogen is a contributory factor in the development of ageing phenomena and in causing poor magnetic qualities in silicon–iron transformer sheets. Alloying elements can overcome these effects in some degree by encouraging the formation and precipitation of free nitrides from the solid solution of nitrogen in iron. The problem centres, therefore, on a more exact knowledge of the effect of these alloys and the conditions under which free nitride phases can be formed. Experiments are in progress in which alloy steels are progressively nitrided at various temperatures in order to discover when nitride phases are produced.

The Refractories Section is investigating the composition and performance of lining materials. Very little is known about the influence of mechanical and flow properties of basic bricks, particularly when heavily contaminated, on their behaviour in a furnace roof. Measurements of crushing-strength are being made at temperatures up to 1,100° C. on specimens cut from used bricks. At this temperature the materials still behave elastically. In addition, a study is being made of the plastic properties at higher temperatures under different rates of strain corresponding to various rates of bursting expansion or lateral compression.

The Corrosion Section exhibited many specimens from field trials of various methods used for protecting iron and steel from corrosion in the atmosphere, in salt water, and in soil. An interesting piece of equipment is the rotor test apparatus which has been built to facilitate laboratory study of the corrosion factor in iron and steel exposed to flowing water. The liquid medium can, of course, be varied, and different natural conditions can be reproduced as the investigation requires. By rotating the specimens at speeds up to 15 knots, the effect of corrosion on moving ferrous objects—such as ships' hulls—can be simulated. The flowing liquid also substantially speeds up the onset of corrosion, a factor of some importance in facilitating investigations.

Physics Department. Two important advances have been made in steelmaking processes as a direct result of research work in the Physics Department. The continuous casting of steel has long been recognized all over the world as likely to have considerable economic advantages over conventional ingot casting. Research has been carried out for the past few years in the London laboratories, and its outcome is an experimental production plant, which began operation in April 1954, for the continuous casting of special steels in a member's works. This is the first two-strand plant ever to be operated by the British steel industry, and it provides a very good example of co-operation between a research association and its industry. Eleven interested companies have formed a development group to finance the capital and running costs of the continuous casting installation

A second advance has been the development of a new burner for oil or oil and coke-oven gas used in open-hearth furnaces. A study of existing burners in which the fuel was atomized at the back end of the burner showed that a high proportion of the input energy was being wasted. Measurements of the momentum-producing efficiency showed that it was better to dispense with back-end atomizers, and to allow liquid fuel to be accelerated gradually towards the burner tip where atomization occurs. The Association's burner is thus very simple to construct. Trials on several open-hearth furnaces carried out jointly by the staff of member firms and the Association have shown very important improvements in increased productivity, longer furnace-roof life, a more efficient use of steam, and the lower cost of fuel per ton of steel produced[1].

The cleaning of industrial gas and fume is a topic of enormous national importance, and the Department is preparing to play an increasing part in the study of this problem. Fundamental work in 'particle capture' has shown that to be effective the water must be in droplets comparable in size to the dust particles, and the essential weakness of the existing spray method lies in the great variation in size of the droplets produced. An experimental unit was therefore devised incorporating spinning disks, in which the gas passes through an annulus surrounding five disks on a common shaft, rotating at speeds up to 5,000 r.p.m. The gas then passes through a bank of irrigated cyclones to remove the water droplets carried forward. For particles 1–76 μ in diameter, overall efficiencies exceed 98 per cent, but this falls to about 60 per cent for particles less than 1 μ in diameter. Further work is being carried out to improve this performance.

Dust-laden gases from many industrial processes are being studied, and valuable data are being accumulated. This will help in selecting suitable plant for specific conditions, and in estimating the efficiency of various types of cleaning plant.

---

[1] Bramley, L. N., *J. Iron and Steel Inst.*, 173, 53 (Jan. 1953).

THE NEW MEGAVOLTAGE RADIOTHERAPY UNIT AT MANCHESTER

THE Christie Hospital and Holt Radium Institute, Manchester, the largest radiotherapy centre in the world, has recently received important additions to its X-ray equipment, in the form of a 4-million volt linear accelerator and a 20-million volt betatron. Both machines were made by the Metropolitan-Vickers Electrical Co., Ltd., at Trafford Park, Manchester, the former being purchased by the Ministry of Health as part of a plan to equip key radiotherapy centres with this type of apparatus. The betatron is the gift of the makers to the Christie Hospital.

The machines are housed in a specially designed building, provided by the Medical Research Council, which is also financing the work to be done with them. This building provides the usual patients' waiting rooms, examination rooms and medical offices, and also a workshop, photographic dark-room and a number of laboratories. Some of these will be used by the physicists attached to the department, while others can be occupied by teams from the main research laboratories of the Christie Hospital, when they are working with the megavoltage radiations. Since it will be necessary to compare the effects of the high-energy radiations with those of the familiar 'deep therapy' range (200–300 kV.), the new department also has a 300-kV. 'Resomax' X-ray tube for this comparison work.

The linear accelerator is of the travelling wave type[1], in which electrons are accelerated by 'surf-riding' on radio waves, the speed of which increases down a corrugated wave-guide. For the acceleration of electrons to an energy of 4 MeV. a tube of only 1 metre long is needed, and this can be mounted on a single-ended gantry-type of mounting (Fig. 1), which can be swung about a horizontal axis, so that the X-ray beam can be aimed in any direction from 15° beyond the downward vertical to 15° beyond the horizontal (a total swing of 120°). Collimation of the beam is by means of adjustable diaphragms of lead, lined with tungsten 'heavy' alloy; treatment fields (at 1 metre) varying from 4 cm. × 4 cm. up to 25 cm. × 30 cm. can be obtained. Circular fields are obtained by inserting lead blocks, pierced by conical holes, between the jaws of the collimator. Since for megavoltage radiations the intensity falls off rapidly on either side of the central axis of the beam, a conically-shaped filter has to be used to produce a uniform field of irradiation. Under such conditions, dose-rates up to 200 r. per min. at a metre from the target can be obtained.

In the betatron[2], the first of its kind to be used in Britain for medical purposes, electrons are accelerated as they circle around inside a magnetic field which is increasing sinusoidally. The electrons reach their maximum energy in 1/600 sec., in which time they have travelled some 300 miles, gaining 80 eV. of energy on each of their 250,000 revolutions around the magnetic field. The magnet, which weighs 7½ tons, and the acceleration vessel or 'doughnut', are mounted so that they can rotate through an angle of 120° about a horizontal axis (Fig. 2). Thus the X-ray beam can be fired in any direction from 15° above the horizontal to 15° beyond the vertical downwards. In addition, the framework carrying the magnet can be raised or lowered through a distance of 7 ft., so that the machine has all the freedom of movement required for radiotherapy.

The collimation of the beam in this machine is by means of cylinders pierced by suitable conical holes, inserted through the lead protective wall placed in front of the doughnut. So that these cylinders shall not have eddy currents induced in them by the changing magnetic field, and yet provide adequate radiation shielding, they are made of a mixture of lead shot and litharge. Each will carry its own compensating filter to give a uniform intensity of radiation across the treatment area.

The beam at 20 MeV. is even narrower than at 4 MeV., and therefore the maximum field reasonably attainable is much smaller than with the linear accelerator, and is a circle of 13 cm. diameter at 1 metre. With the compensating filter in position, the betatron delivers about 50 r. per min. at a metre from the target.

Though these new machines will be used in the Hospital's main research programme into the action of radiations on living tissue, and though the irradiation of biological materials will serve as an invaluable aid in deciding correct dosage for the treatment of patients, the main function of the new equipment is the treatment of cancer.

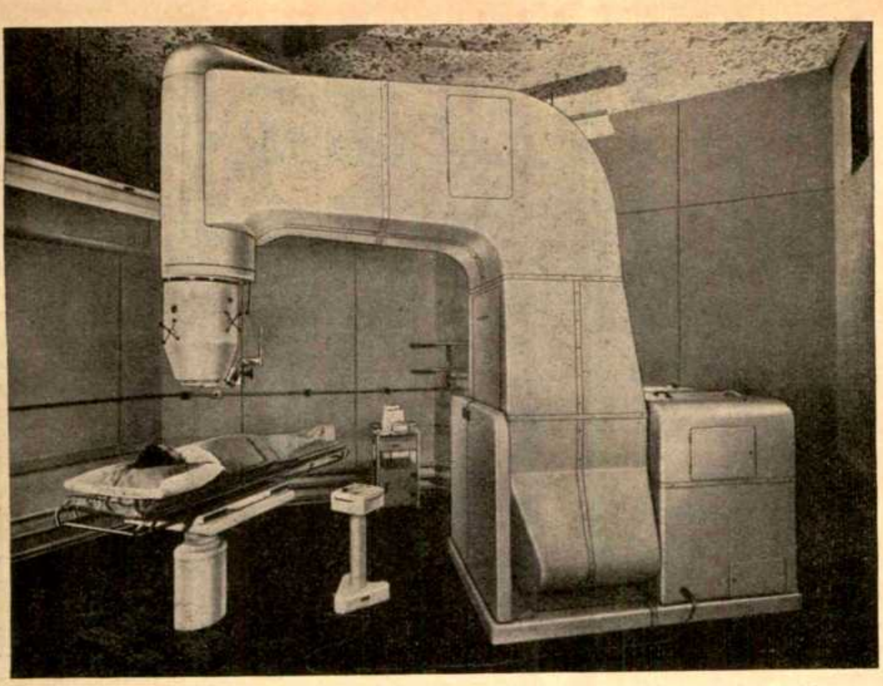


Fig. 1. Metropolitan-Vickers 4-MeV. linear accelerator with X-ray beam in vertical position

In radiotherapy, it is often necessary to treat a cancer growing deep in the body. To do this an adequate dose of radiation must be delivered to the tumour area without overdosing other parts of the body. This is usually achieved by using a number of X-ray beams aimed at the tumour from different directions. The more penetrating the X-rays, the fewer the number of beams that have to be used, or the smaller the dose which each beam has to give to the normal tissue through which it passes.

Since the penetrating power of a beam depends on the voltage used for its generation, the first advantage offered by megavoltage radiations is increased penetrating power, and hence the ability to treat deep tumours much more efficiently. The radiations, however, have other considerable advantages. One is that they are less scattered than are lower-energy rays, and thus the amount of radiation received by tissues outside the geometric confines of the beams is greatly reduced. Another advantage arises from the behaviour of the electrons set in motion by the attenuation of the X-ray beam in the material through which it passes and which are responsible for most of the effects of the radiation. These travel predominantly forward in the direction of the beam, and, giving up most of their energy at the end of their track, produce the highest dose some distance below the surface. For 4-million volt X-rays, the maximum is about 1 cm. below the surface, while for 20-million volt X-rays it is as much as 4 cm. deep. With these radiations, therefore, the effect on the skin is greatly reduced and skin reactions, so troublesome at 250 kV., are practically eliminated. A further advantage arises from the fact that scattering, which depends but little on atomic number, is the predominant mechanism by which the beam is attenuated at these energies, and thus the absorption of the rays in bone and in soft tissues is much more nearly equal than it is at lower voltages. Therefore there is far less danger of overdosing bones and of underdosing, because of the shadow effect, tissues which lie beyond bone.

While these physical advantages are firmly established, the biological effects of the megavoltage radiations are not so certain. It appears likely that they will be similar to those produced by the familiar 250-kV. range of X-rays, but this is not certain. Some biological effects are dependent on the linear ion density of the radiation, and since this is smaller for megavoltage radiation than for 250 kV., this may have some influence. Further, both machines produce

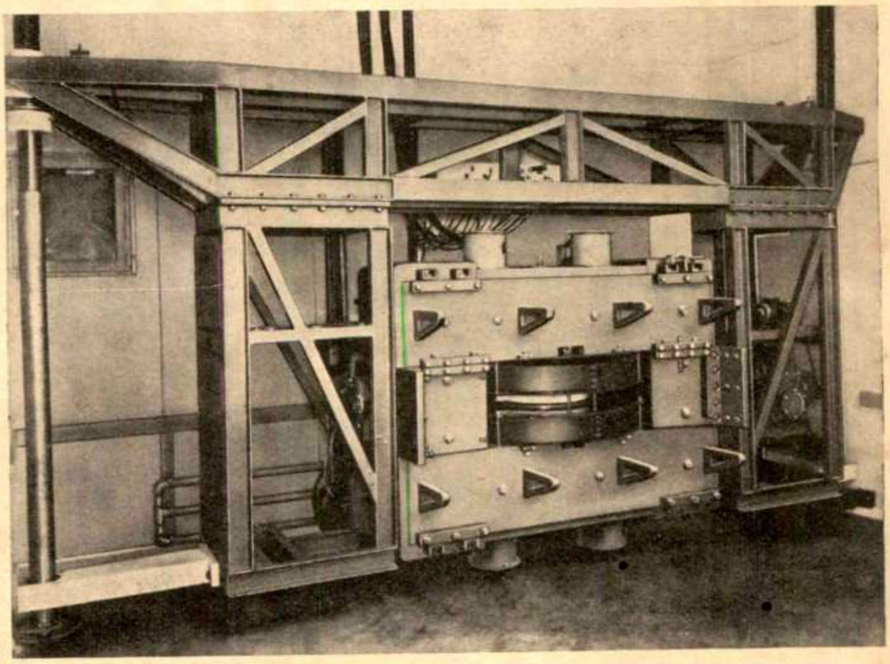


Fig. 2. Metropolitan-Vickers 20-MeV. betatron during installation

radiation in pulses of very short duration, and hence of high instantaneous dose-rate instead of the approximately uniform dose-rate of the conventional equipment, and this again may cause differences. The evidence so far available, in fact, suggests that the high-energy X-rays are slightly less efficient than lower-energy ones in producing some biological effects. Therefore clinical work with the two machines is going forward very cautiously, supported and guided by the results of comparison experiments using various biological and chemical indicators.

It must be stressed that the new machines do not offer any prospect of miraculous cancer cures; but it is confidently hoped that they will increase the proportion of cures already being attained with lower-voltage apparatus. Of one thing there can be no doubt: this unit offers unique opportunities for the study of the effects of ionizing radiations in malignant diseases.

---

[1] Fry, D. W., *et al.*, *Nature*, **160**, 351 (1947). Miller, C. W., *Nature*, **171**, 297 (1953).

[2] Kerst, D. W., *Phys. Rev.*, **60**, 47 (1941).

OBITUARY

Prof. G. H. Shull

The death occurred recently of Prof. George Harrison Shull. He was born in Clark County, Ohio, in 1874. After taking his B.S. degree at Antioch College he graduated Ph.D. at Chicago in 1904. His first post was that of student assistant at the United States Department of Agriculture, Bureau of Forestry. After this he was successively botanical assistant a the U.S. National Museum, assistant plant physiologist at Chicago, and botanical investigator a the Carnegie Institution of Washington, where he remained for eleven years. In 1915 he became professor of genetics at Princeton University, where he worked until his retirement in 1942.

Prof. Shull is principally known for his pionee work on pure lines in maize, which laid the foundations of the huge hybrid-maize industry of the United States, based on the crossing of lines which had been inbred for long periods. But throughout his long and productive scientific career he worked extensively on a variety of topics. He concerned himself, among other things, with the heredity of sex in *Melandrium*, linkage and mutation in *Oenothera* and with self-incompatibility in *Capsella*.

Many academic honours were conferred on Shull including honorary doctorates from Lawrence College and Iowa State University. He was a member of, and took an active part in, the administration of the Genetics Society, the Eugenics Research Association the Philosophical Society, and the Torrey Botanica Club, of which he was president in 1947.

Prof. Shull was among the few remaining workers in genetics who date back to the early years of Mendelism. A final word must be said about one of his most noteworthy characteristics. He devoted much time and thought to young workers and was always ready to draw on his vast knowledge and experience for their guidance. A simple, kindly and serene man, he will be much missed.

S. C. Harland

NEWS and VIEWS

New Year Honours

The following names of scientists and others associated with scientific work appear in the New Year Honours list:

Baron: Dr. E. D. Adrian, president of the Royal Society and also of the British Association.

K.B.E.: Sir John Stopford, vice-chancellor, University of Manchester; Dr. Owen H. Wansborough-Jones, chief scientist, Ministry of Supply.

Knights: Prof. Wilfrid E. Le Gros Clark, Dr. Lee's professor of anatomy in the University of Oxford; Prof. Leybourne S. P. Davidson, professor of medicine in the University of Edinburgh, and president of the Royal College of Physicians of Edinburgh; Dr. Keith A. H. Murray, chairman of the University Grants Committee; Dr. Oliver G. Sutton, director of the Meteorological Office (Air Ministry) and president of the Royal Meteorological Society.

C.B.: G. R. D. Hogg, Under-Secretary, Department of Scientific and Industrial Research.

C.M.G.: D. M. Balme, principal of University College, Gold Coast; B. A. Cash-Reed, attaché for food and agriculture at the British Embassy in Washington; Dr. R. Lewthwaite, director of Colonial Medical Research; Prof. W. L. Waterhouse, lately professor of agriculture in the University of Sydney, for services to the wheat industry in Australia; T. Y. Watson, Secretary for Agriculture and Natural Resources, Uganda.

C.B.E.: C. E. J. Biggs, director of agriculture, Tanganyika; C. S. Bryant, lately director of materials and explosives research and development, Ministry of Supply; Dr. C. J. Gadd, keeper, Department of Egyptian and Assyrian Antiquities, British Museum; Dr. M. W. Goldblatt, director, Industrial Hygiene Research Laboratories, Imperial Chemical Industries, Ltd.; Dr. A. W. Greenwood, director, Poultry Research Centre, Edinburgh (Agricultural Research Council); W. F. Grimes, director, London Museum; G. W. Lines, director of agriculture, Sierra Leone; P. McNee, director, Drainage and Irrigation Department, Federation of Malaya; Prof. R. Peers, emeritus professor of adult education in the University of Nottingham, chairman of the Central Committee for Adult Education in H.M. Forces; Miss Audrey I. Richards, director, East African Institute of Social Research, Makerere College, Uganda; F. S. Russell, secretary of the Marine Biological Association of the United Kingdom, and director of the Plymouth Laboratory of the Association; E. E. Shipton, explorer and mountaineer; Prof. C. H. Smith, professor of instrument technology in the Royal Military College of Science; Dr. E. L. Taylor, deputy director, Veterinary Laboratories, Ministry of Agriculture and Fisheries; Prof. G. F. J. Temple, Sedleian professor of Natural Philosophy in the University of Oxford; L. C. Wilcher, principal of the University College of Khartoum, Sudan; J. Wright, director of agriculture, Jamaica.

Instrument Technology in the Imperial College, London: Prof. J. D. McGee

The recent announcement that Dr. J. D. McGee had been appointed by the University of London to the University chair of instrument technology provides an interesting example of the expanding activities of the Imperial College of Science and Technology At an earlier period of its history, nstrumentation had been represented there by the chair of instrument design held by the late Prof A. F C. Pollard, but on his retirement no successor was appointed Prof McGee's particular interests ie in the field of photoelectric, electronic and television techniques rather than in the mechanical design of instruments, and as head of the new post-graduate Section of Instrument Technology in the College, he will be responsible for the development and application of these and similar devices to physical problems

Educated at the University of Sydney, and awarded in 1928 an 1851 Exhibition travelling scholarship, he worked for three years under Lord Rutherford at the Cavendish Laboratory From there, he went to the research laboratories of Electric and Musical Industries, Ltd, where he first worked on the development of high-vacuum cathode-ray tubes for television picture reception and later directed the research group which had been given the task of developing the pick-up tubes used in television cameras During the War he was especially concerned with infra-red image converter tubes, not only with their development in the laboratory, but also with their factory production and with their military application After the War, Prof McGee was in charge of the group at Electric and Musical Industries, Ltd, responsible for striking developments in television camera pick-up tubes, charge storage tubes and photoelectric electron multipliers These techniques are likely to be exploited to great advantage in the new Instrument Technology Section of the College A staff of wide experience is being recruited and will help to establish a senior school of instrument technology that can be expected to make major advanced contributions to science and ndustry

Jacques Dubois (Jacobus Sylvius) (1478–1555)

JACQUES DUBOIS, who died in Paris four centuries ago on January 13, 1555, was a humanist who made many original contributions to anatomy and helped to reform its teaching. The son of a weaver, he was born in 1478 at Louville near Amiens, from which town he derived his Latin cognomen Jacobus Sylvius Ambianus As a student at the college of Tournay near Paris, he excelled in Latin, Greek, Hebrew and mathematics, invented machines for transporting water and wrote a popular French grammar After studying medicine in Paris, he travelled widely to mprove his knowledge of pharmacy Despite his ack of a degree, which he was too poor to obtain, his success as a teacher was so great that the Paris medical faculty stopped his courses because they nterfered with the regular schools. Sylvius then went to Montpellier, where he graduated in medicine on June 28, 1531, and on his return to Paris taught anatomy at the Collège de Tréguier, insisting that this subject can only be studied from the human body by eye and touch, and not by reading and description Though he often followed Galen blindly, he succeeded in clarifying many of the garrulous and obscure passages He frequently had five hundred pupils, who included Vesalius, Servetus, Conrad Gesner and Charles Estienne He gave specific names, some of which are still in use, to the muscles which Galen had designated by numbers, described the valves in the veins, and the sphenoid bone, and was a pioneer in practising the art of injection At the age of seventy-two he was appointed professor of surgery at the Royal College of Paris The aqueduct and the fissure of Sylvius were described by another Sylvius (François de la Boe) a century later

Zoological Society and B B.C. Expedition to West Africa

THE expedition organized jointly by the Zoological Society of London and the British Broadcasting Corporation returned to Britain just before Christmas from ten weeks field-work in Sierra Leone, bringing a large collection of animals and a considerable quantity of cinematograph films and sound recordings. The animals are for the Society's collection at Regent's Park, London, and the films and recordings are for the B B C's television service—some programmes have already been broadcast One of the main objects of the expedition was to find the nesting habitat of *Picathartes gymnocephala,* a rare passerine bird the systematic position of which is obscure; this bird has seldom been seen alive by Europeans. The habitat was found in difficult hilly bush country, and in spite of the dense shade cast by the forest successful films were made of the birds on and near the nests, of the eggs and of the parents feeding the young by regurgitation Sound records were also obtained of the voices of the birds in their natural surroundings, and a living specimen was captured and brought to London Another species never before exhibited in captivity that was successfully sought and found is the brilliantly iridescent emerald starling *Coccycolius iris* Small flocks of this bird were discovered in the open savannah country of the highlands in the north near the French border Much interesting film was made of various invertebrates, including several species of ants such as the driver, fire and Matabele ants, mantids, nest-building Hymenoptera and termites, as well as many subjects among the vertebrates A further series is of particular anthropological interest as it shows some of the ritual dances used in connexion with the initiation ceremonies of the secret societies that have such a powerful influence over the lives of the pagan natives Lengthy sound-recordings of the music and songs accompanying these dances were also made The Zoological Society and the B B C hope that the results of this joint venture will justify the organization of further field-expeditions to other parts of the world in the future

Pool of Spraying and Dusting Equipment

A POOL of spraying and dusting machinery for use in the Colonial territories is being established by the Colonial Office, in co-operation with the Imperial College of Science and Technology and the machinery manufacturers, at the Imperial College of Science and Technology Field Station, Silwood Park, Sunninghill, Berks Manufacturers of spraying and dusting machinery have been approached through the Agricultural Engineers Association and are co-operating in the establishment of the pool by the loan of suitable equipment The College has for some years maintained a representative collection of spraying and dusting machinery for teaching and experimental purposes, and this collection will be incorporated into the pool, which will include equipment designed for agricultural, stored products and public health work The pool will fulfil three purposes (1) the instruction of students (especially students preparing to undertake work in the Colonies) of agriculture, entomology, mycology, etc , in the different types of equipment, their use and maintenance , (2) the demonstration of the equipment to interested potential users in the Colonies , (3) the consideration of modifications to machinery to meet special conditions of tropical use A comprehensive reference library of spraying- and dusting-machinery manufacturers' literature is to be formed for the use of visitors A committee on which the Colonial Office, the Imperial College, and the Agricultural Engineers' Association are represented has been set up and is responsible for the running of the pool and for the selection of machinery offered by any manufacturers for inclusion in the pool Mr A E H Higgins, Imperial College of Science and Technology, London, S W.7, is in charge of the pool

Hilger Journal

The first number of the *Hilger Journal*, published in November 1954, is an illustrated pamphlet of eight pages of which approximately one-quarter is devoted to abstracts of recently published papers on spectroscopy. The issue contains also an account of the Hilger equipment installed in the new research laboratories of the Quasic Arc Company, Bilston, Staffordshire, and an extract concerning the use of optical methods from a talk by Dr J Haslam, of the Plastic Division of Imperial Chemical Industries, Ltd , on physical methods in the analysis of plastic materials With regard to a new and complete direct–direct spectrograph, known as a polychromator, the merits and demerits of the two main systems of spectrochemical analysis, photographic and direct reading, are explained. A special Schwarz thermopile which can be used as a replacement in certain types (not Hilger) of infra-red spectrometers has been designed and details of its application are to be studied , but meanwhile a preliminary catalogue description has been prepared and is available on request from Hilger and Watts, Ltd , 98 St Pancras Way, London, N W 1

Central Leather Research Institute, India News Bulletin

The Central Leather Research Institute, which was opened in Madras in 1953, is one of a chain of twelve National Research Institutes established by the Government of India under the ægis of the Council of Scientific and Industrial Research The scope of its work is to "carry out research in all aspects of leather industry, to solve problems which confront particularly the Indian leather industry and also to contribute to the international leather research which is being directed to extend leather science". It has now issued its first monthly bulletin (1, No 1 , August 1954 , pp 26 From the Institute, Adyar, Madras-20. Annual subscription Rs 9 or 18*s* , single issues Rs 12) It is stated that each bulletin will contain abstracts, research papers of the Institute, other articles on leather technology and trade advertisements In this issue, there are two articles The first deals with "Some Aspects of Leather Manufacture" and is by Prof B M Das, a recognized authority of long standing. Reference is made to the work of the Institute on the use of native barks to replace imported wattle extract, the presence of different tannins in avaram bark, rapid sole-leather tannages, new syntans from Indian coal-tar distillation products, basic aluminium salts in spray-dried powder form and tanning agents from mineral oil The second article describes the improvement of the tanning properties of mangrove liquors by modification of their acid and salt contents Th bulletin is well produced and of considerable interes in Britain, because the Institute seeks to improve th quality of the raw and crust-tanned hides and skin exported to this country

Insecticide and Repellent Action of Certai Chemicals

A handbook giving the results of tests of insecticidal action and repellency on fifteen species o insects and arachnids of medical importance ha been compiled by W V King, of the Agricultura Service of the United States Department of Agriculture, and published as Agriculture Handboo No 69 under the title of "Chemicals evaluated a Insecticides and Repellents at Orlando, Fla" (p 397 Washington, D C Govt Printing Office, 1954 2 25 dollars) Eleven thousand chemicals were included in the tests, each chemical being graded int one of four or five categories according to its efficiency A brief description of the methods of testing is give The results give some indication whether or not th chemical tested had marked insecticidal or repellen properties to the particular species of insect on whic it was tested , but, in the absence of any informatio on the reproducibility and degree of variation of th results, it does not seem possible to assess whethe the difference between the categories listed is reall significant A critical study of the test method employed would add greatly to the value of th results It is stated that the data are presented i the belief that they may prove useful to worke engaged in the development of new insecticides or i the study of the relation of chemical structure t insecticidal activity, 'and this may well prove t be so.

Medicine in the Atomic Age

The November issue of *Medicine Illustrated* co sists of a number of articles under two gener headings peaceful uses of atomic energy , an atomic warfare, medical aspects Prof J Rotbl describes with admirable clarity for the layman th nature and production of radioisotopes, and Mr Veall has the hard task of selecting examples of ho these isotopes are used in investigation and diagnos Drs R Bodley Scott and R M Cunningham a clear in describing the uses of phosphorus-32 an iodine-131 for therapy, and Dr R J Walton surve the therapeutic uses of other radionuclides Mr Dunster, as a health physicist, explains how person protection is achieved and how contaminated was can be disposed of Prof. K. Mather ends a go collection of papers with an admirable survey of t genetical price of radiation On the medical aspec of atomic warfare, the authors are on a mu 'stickier wicket' and, like the most skilled performe in such conditions, are guilty of many lapses fro orthodoxy However, few would dare to predict t future in this field, so that in general any stimul to thought is good. From an illustrated journal o would have expected more pictures and less scri and surprisingly many of the illustrations are ve poor , by far and away the best is an abstract fro a case report by L H Hemplemann with colour plates from *Medical Radiography and Photography*

Aerosurvey by Photography

Mr. A. D. Dodds-Parker, Parliamentary Und Secretary of State for Commonwealth Relations, w open an exhibition of photography in aerial survey work at the Kodak Gallery, 184 Regent Street, London, W 1, on January 10 The exhibition shows something of the activities of Hunting Aerosurveys, Ltd , Hunting Geophysics, Ltd , and Aerofilms, Ltd Hunting Aerosurveys, Ltd , are concerned mainly with stereoscopic photography for map-making , Hunting Geophysics, Ltd , engage in mineral prospecting , and Aerofilms, Ltd , specialize in 'oblique' shots of towns, well-known land-marks and industrial projects The exhibition will be open to the public during January 11–29 (Mondays to Fridays, 9 30 a m –5 p m , Saturdays, 9 30–11 30 a m), admission is free.

University of London : Appointments

The following appointments in the University of London have been announced Mr. G A Barnard, reader in mathematical statistics in the Imperial College of Science and Technology, to the University chair of statistics tenable at that College , Prof Arnold Tustin, professor of electrical engineering in the University of Birmingham, to the University chair of heavy electrical engineering tenable at the Imperial College of Science and Technology , Dr Paul Fatt, senior research fellow in physiology at the Australian National University, Canberra, to the University readership in biophysics tenable at University College The title of professor of zoology in the University has been conferred on Dr G P. Wells in respect of his post at University College, London.

University of London : Awards

The following awards made by the University of London have been announced *I C I Fellowships*, each of the value of £750 per annum, and tenable in the first instance for three years D R Bland, for research in theoretical mechanics, in particular in plasticity and heat transfer, at the Imperial College of Science and Technology , Dr G W H Cheeseman, for research on the chemistry of organic nitrites and nitrates, at Queen Elizabeth College , Dr G. L Sewell, for research on the fundamental theory of condensed matter, at the Imperial College of Science and Technology , Dr G H A Cole, for research in the field of ionic physics, at University College , Dr R. Pettit, for a study of conjugated organic molecules containing one or more hetero atoms, at Queen Mary College , *Turner and Newall Research Fellowship*, of the value of £750 per annum, and tenable in the first instance for three years, to Dr. T J Lewis, for research on the electrical strength of pure liquids, at Queen Mary College.

Announcements

Prof Robert Cruickshank, professor of bacteriology in St Mary's Hospital Medical School, London, has been appointed principal of the Wright–Fleming Institute of Microbiology at the School in succession to Sir Alexander Fleming, who has retired.

Dr Reginald Child has been appointed director of the Tea Research Institute of East Africa in succession to Dr T Eden, who retired in June Dr Child has been senior chemist of the Institute since its inception in 1951 (see *Nature*, 169, 959 , 1952).

The Thomas Young Oration for 1955 of the Physical Society will be delivered by Dr W S Stiles (National Physical Laboratory) on February 25, in the lecture theatre, Science Museum, London, S W 7, at 5 p m , Dr Stiles will speak on "The Basic Data of Colour-matching and Some Related Aspects of Visual Theory"

The spring meeting of the Physical Society will be held at the Atomic Energy Research Establishment, Harwell, during March 31–April 2 The subject of the meeting will be "Neutron Physics and Energy Levels" Accommodation can be arranged at Lincoln College, Oxford, provided notification is received at A E R E, Harwell, not later than January 31 Application forms to attend the meeting can be obtained from the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S W 7

A pamphlet on selenium, by R Ashton, E G Hill and D Neville-Jones (London H.M S O , 1*s* 6*d* net), gives a concise but very informative survey of the sources, production and uses of selenium, and includes the use of selenium in the glass industry and selenium rectifiers (as an alternative to germanium) There is at present a shortage of selenium, and possible alternatives are discussed

A technical data sheet, of thirty-four pages, on piperidine has been issued by Robinson Bros , Ltd , of Ryders Green, West Bromwich, Staffs It contains a survey of the physical and chemical properties of piperidine and descriptions of reactions in which it is used, with complete references to the literature, and is likely to be of service in chemical laboratories In addition to pure piperidine, the commercial varieties are considered. The document is very useful in that it contains information not otherwise easily available.

A symposium on "The Protection of Structural Steel", organized by the Corrosion Group of the Society of Chemical Industry, will be held in London in the lecture theatre of the Institution of Civil Engineers during March 31–April 1 Those contributing papers will be from Belgium, France, Holland, Sweden and the United States, as well as Great Britain, and accounts will be given of practical experience and of research with protective coatings Further information can be obtained from the honorary secretary of the Group, S C Britton, Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex

A series of seven lectures on "The Shape of Work to Come" is being given at St Anne's House, Soho, on Thursdays at 6 30 p m , beginning January 13. The speakers will include the Right Hon. L J Edwards, on the philosophy of work , Mr J R Gass (Intelligence Division, Department of Scientific and Industrial Research), on the implications of automatic production , Dr R W Revans (formerly director of education, National Coal Board), on the scale and structure of industry , Mr A Healey (British Institute of Management), on the significance of industrial psychology and welfare , Dr M. M Fmiston (Atomic Energy Research Establishment, Harwell), on the transformation of society by the coming of atomic power , Prof Michael P Fogarty (professor of industrial relations, University of Wales), on the true end of man and his work Admission is by ticket only, obtainable from the Secretary, St Anne's House, 57 Dean Street, Shaftesbury Avenue, London, W 1 , single lectures, 2*s* (house members 1*s* 6*d*), season tickets, 12*s*. 6*d*. (house members 10*s*)

RESEARCH AND INDUSTRIAL PRODUCTIVITY

DURING November 22–25, the Department of Scientific and Industrial Research, in association with the British Productivity Council, held a working conference on "Research and Industrial Productivity" At its opening luncheon, the Lord President of the Council, Lord Salisbury, stated the national problem, that unless we can work to better advantage, making full use of the knowledge which science can provide, Britain will be unable to maintain its social services and exercise its proper influence in world affairs The conference itself was directed both to the considerations which determine whether and how quickly a scientific or technological advance can be successfully introduced into industry, and also to the scientific studies by which management and work can be improved so as to yield a higher productivity The British Productivity Council and many industrial leaders participated, but the body of the conference came mainly from the councils and staffs of research associations, nationalized industries, and a few from government departments.

At the first session, Sir Ben Lockspeiser recalled that King George V, when Prince of Wales, had described the problem in opening the National Physical Laboratory half a century ago Since then, Sir Ben said, we have developed a greater social conscience and Britain's share in world trade has diminished To maintain and increase our living standards we must both expand our production and increase its efficiency We must particularly seek increased efficiency with a minimum of capital investment, because this is a charge on productivity Similar economy is essential in raw materials. He instanced selenium, where electric and electronic equipment may have a higher claim than brighter milk-bottles Nor is there a reservoir of technical talent or of labour Technologists must be used sparingly The partially or fully automatic factory may go far in meeting labour shortage

Sir Ewart Smith, vice-chairman (now chairman) of the British Productivity Council, showed that, in spite of recent favourable trends, the rate of increase in productivity in Britain has been, for a considerable period, consistently less than in the United States, although at one time the rates had been the same We ought to aim at an increase of 10 per cent per annum in the hope that few would fall below 5 per cent and many would achieve 7 or 8 per cent with a reasonable number attaining 10 per cent He analysed the functions of research, management and operational study He indicated that the research outlook is essentially that which would provide the information and principles on which management decisions should be based and by which improved practice could be instituted on the shop floor The advantages of automatic operation must be balanced against maintenance work and first cost, but there is the opportunity of transferring labour from routine to interesting work Although research associations and such bodies cannot do industry's job, yet they can and must provide the basic information, the principles and the encouragement to hasten the industrial revolution which, as Sir Ben had said, is now on the way

In opening the discussion, Dr S Whitehead, chairman of the Committee of Directors of Research Associations, said that, additional to those research associations which have operational departments, many others decentralize such work He instanced certain difficulties, such as in making an economic case for change and capital investment, workers' co-operation in research, natural inertia and over-indulgence in pride in past achievement and standardization Nevertheless, research associations must sincerely accept the tasks put by Sir Ben and Sir Ewart both by making the necessary studies and in producing a favourable industrial climate of opinion Dr B K Blount, deputy secretary of the Department of Scientific and Industrial Research, remarked that the stations of the Department serve many industries and deal with problems of national well-being He gave instances to show their insistence on practical application to essential needs In addition, the Department has central services for studying efficiency and the human element, and to help in all kinds of operational research and information problems The general discussion turned on the best strategy of approach to industry, and specific problems such as local redundancy

In a session on materials, Mr. D A Oliver, director of the B S A Group Research Centre, said he thought that private enterprise could not unaided exploit mineral resources fully on a long-term plan owing to shortage of risk capital and man-power, insufficient technical resources, lack of information and the uncertainty of world conditions He proposed that the government should co-operate by the setting up of a minerals advisory bureau, the continuous study of consumer demand and the provision of a national mineral-dressing and process metallurgy laboratory Although the type of assistance proposed was agreed in the discussion, there were differences as to the mechanism and the institutions which should be responsible Prof S. Zuckerman stressed the desirability of living on income rather than capital Synthetics do not usually replace natural materials, he said they satisfy new needs and often make large demands upon non-renewable resources such as coal and oil Conversely, synthesis can shift the burden to renewable resources such as cellulose If photosynthesis could be understood and made efficient, solar energy and renewable organisms would be much better than chemical factories These considerations often conflict with short-term profitability, but we must strive towards the best balance, in which both productivity per acre and per man are important In the discussion the effort was mentioned that has already been made to reduce waste and recover used materials, though the present economic value of recovery does not always represent its ultimate value Pest destruction could give an immediate saving, and advance in fertilization would increase yield per acre, but in Prof Zuckerman's view there is a long way to go

Mr K. T Spencer, chief scientific adviser, Ministry of Fuel and Power, recalled that the industrial progress of Britain has been based on cheap coal. An expanded and competitive industrialization demands more fuel At best, nuclear energy will leave for ten years or more an increasing gap between demand and supply No spectacular increase in coal production has followed mechanization, and the quality has deteriorated We have provided for increased use of oil, but greater dependence on imports is ultimately unsatisfactory We must, therefore, use fuel more efficiently Railway electrification could save 13 million tons of large coal at the cost of 5 million tons of poor coal The domestic open fire is condemned anyhow by pollution Improvements in fuel efficiency have been achieved in collieries, in the ceramics, the iron and steel and the laundry industries, but comparisons show that there is great room for improvement in industry as a whole by the intelligent use of existing data Research associations could give a lead to industry in this and several have done so, but industry must respond to advice on this central essential problem irrespective of local incentives, since some industries are large coal users but have a low proportionate fuel cost

Dr W A MacFarlane, director of the National Industrial Fuel Efficiency Service, described the National Fuel Efficiency Service, which has taken over and expanded the service of the Ministry of Fuel and Power The Service finds sources of waste, improves operation, makes detailed inspections and full heat and power surveys He stressed the importance of data on low-pressure steam Mr O F Thompson's paper dealt with economic factors in the provision of low-cost energy in the future Research was urged on economic forecasting, capital resources and availability, and the effect of taxation In the discussion, attention was directed to what has been done in collieries, the advantages of pithead electrification, and the reduction between 1920 and 1938 from 1,550 tons to 670 tons needed to generate a million kWh, since 1938 the firing coal used for ceramics has fallen from nearly 1 25 to 0 4 million tons Economy is possible in the labour used in obtaining and using fuel Although water-power, wind-power, terrestrial heat and solar radiation might make no great contribution, they should be used There is no doubt as to the informed interest in fuel efficiency.

Prof C F Carter, of The Queen's University, Belfast, urged examination of the business hurdles which innovations must surmount—capital investment and risk, the amount and period of profitability, the uncertainties of markets and supplies, the interval required to achieve success He believes that nowadays managements are less willing to take risks, but, conversely, with full employment and an inflationary tendency, the risks are less. Dr R M Lodge, research manager of British Nylon Spinners, Ltd, in a paper on the economic factors in the planning of research, referred to economy in the use of scientists, the modern growth of team-work, freedom of atmosphere and the minimum and maximum of expenditure, which are related to the amount of development work This is much more costly than research and should be more carefully planned, bearing in mind production and sales Mr A H Wilson, director of research and development, Courtaulds, Ltd, in a paper on the economics of re-equipment, dealt with some of the questions raised by Prof Carter and discussed the economic effect of discarded plant when changing an existing industry as compared with founding a new industry Dr F M Lea, director of the Building Research Station, Department of Scientific and Industrial Research, illustrated in the building industry, where there are few large firms and not much capital, the influence of new machines (such as the tower crane) and methods on productivity and the organization to secure it He showed how these considerations have determined the work of the Building Research Station Mr R T Eddison, of the British Iron and Steel Research Association, used the example of the handling and transport of iron ore to show how the best compromise can be reached in choosing a method of working, when several different resources are needed which are differently, perhaps oppositely, affected by changes and where the simple criterion of cost might need some qualification The various discussions on these papers agreed as to the necessity of economic appraisal, but there was divergence as to how it should be done Similarly, the planning of research against the background of application was admitted, but not the detailed methods the mention of sponsored research provoked discordance The opinion was expressed that large concerns in the United States are no more venturesome than British industry It is clear that the study of the effect of innovation upon production and operation is widespread

The next two sessions were devoted to the human factor Mr R M Currie, head of the Central Work Study Department, Imperial Chemical Industries, Ltd, stressed the need for research into work study, which he said is an important tool in management and also is based on the same principles as scientific research, but its application must be direct and speedy Mr N Pleming, chairman and managing director of Associated Industrial Consultants, Ltd, added the further management tools of cost-control and production-planning and control He thought great improvements could be secured by existing methods, provided co-operation between management and workers is achieved Dr C B Frisby, director of the National Institute of Industrial Psychology, dealt with the adaptation of equipment and work organization to the anatomical and physiological characteristics of the worker This leads to psychophysical features which affect the skill of the worker Lastly, there are psychological aspects which influence the worker's attitude to his task and the satisfaction he gains, and here the relations between workers must be considered.

The two papers from trade union representatives showed some difference of attitude Mr L T Wright, general secretary, Amalgamated Weavers Association, believes that productivity is primarily the function of management, which must also convince the workers that they will benefit as human beings from changes general full employment is not an answer to particular local redundancy Although Mr Crawford, chairman of the National Union of Boot and Shoe Operatives, was as emphatic on a proper appeal to workers', natural human qualities, he considered that they can aid management both in planning and in encouraging a favourable response. He examined incentive schemes, rate-fixing and work-organization and gave examples of successful schemes which have been carefully planned and judiciously introduced to the workers The discussion indicated the general interest in work study, and that the same principles are applicable in many other branches of human activity Mr Crawford's opinion that workers would respond to well-conceived and well-expressed ideas seemed to be accepted

The summing-up of the conference was by Dr. A King (D S I R), Dr F C Toy (Shirley Institute), Mr F. Courtney Harwood (Launderers' Research Association), Mr S. H. Clarke (Fire Research, D.S.I.R.), the Hon. L. O. Russell (Institute of Management) and Sir Thomas Hutton (Productivity Council). The conference had shown how many resources are available for improving productivity and meeting its technical, its economic and its human problems. All these resources are not everywhere known or used. To overcome this there are two main national agencies. The British Productivity Council, with its decentralized regional organization and circuit system, endeavours to bring management and workers together in every main industrial area, making use of modern methods of presentation. The second agency is provided by the research associations and the Department of Scientific and Industrial Research with its stations. These bodies have valuable contacts with industry since they impinge directly on the particular industrial sectors of which they have expert knowledge. They have already done a great deal and are converted to the objects of the conference. Nevertheless, their structure, especially that of the research associations, permits them to do more; the value of the conference will depend upon whether it succeeded in establishing that interest in scientific and technological research should not limit the effort to convert industry as a whole to the principles which those attending the conference accepted.

X-RAY APPARATUS AND ASSOCIATED TECHNIQUES

EXHIBITION IN LONDON

As in previous years, an exhibition of X-ray apparatus was arranged in conjunction with the annual congress of the British Institute of Radiology, and was held at the Royal Horticultural Hall, London, during November 23–26. The majority of the exhibits were concerned with medical applications, both diagnostic and therapeutic, but industrial and scientific instruments were also represented.

Perhaps the most striking feature of modern electronic components and instruments is the way in which improvements in design and in materials have made possible reductions in size and in power consumption. This was well exemplified by much of the X-ray equipment on show. The increased use of oil-immersed components has resulted in compact single-unit power supplies for X-ray tubes, some of them incorporating series triode control valves which permit instantaneous high-tension switching as well as current and voltage stabilization. Another advance in this direction was represented by new oil-immersed high-tension rectifiers the filaments of which consist of thoriated tungsten with a power consumption less than one-third of that of pure tungsten filaments. Another interesting power supply includes a fly-wheel energy-storage generator which makes it possible to obtain a short-duration X-ray burst of very high intensity without drawing a heavy load from the mains supply.

X-ray tubes themselves have become more mobile; oil-insulated industrial tubes permit underwater radiography, and medical diagnostic and therapeutic tubes are mounted on cradles or above tilting tables which allow them and the patients to be moved automatically or with finger-tip control. Higher intensities are provided by the large range of rotating anode tubes. Another approach to the intensity problem in radiography is provided by the development of more-sensitive detecting devices. A new X-ray film is claimed to be 50 per cent faster than any previous type. Of even greater interest, perhaps, are the new image amplifiers, several examples of which were on show. In these tubes X-ray energy is first converted into light energy by a thin fluorescent screen, in contact with which is a photoelectric surface which, in turn, converts the light into electron emission. The electrons are accelerated by a high potential and focused on a final output screen. By these means the limit of brightness for threshold vision is reduced by a factor of 10 1, while the exposure time in fluorophotography is in the ratio of 200 1 as compared with the image produced on a normal fluoroscopic screen.

Artificial radioisotopes are becoming of ever-increasing importance both in therapy and in radiography. This fact was reflected in the many instruments on show for the handling and the detection and measurement of high-activity sources. The measuring instruments exhibited ranged from a simple 'nurse-proof' radiation monitor to fully automatic equipment capable of measuring the activities of up to 425 planchet-mounted samples to any desired degree of accuracy without any intervention from a human operator, the results being printed by the machine.

In X-ray therapy the deleterious effects of radiation on healthy tissue are now guarded against, so far as possible, by arrangements of ingenious geometry such as those employed in arc irradiation and in moving-beam methods. A new possible way of reducing radiation burns, which may be of great potential importance, is the discovery of the inhibitory effect of cortisone injections on acute X-ray damage to animal tissue. Discoveries like the last, together with apparatus as yet in the experimental stage, were demonstrated in a small scientific section at the exhibition. In general, the main commercial part of the exhibition demonstrated that the X-ray industry is quick in developing new ideas to a production stage.

U. W. Arndt

THE AGE OF THE UNIVERSE

The Philosophy of Science Group of the British Society for the History of Science last year offered a prize for "the best essay on 'What is the logical and scientific status of the concept of the temporal origin and age of the universe ?'" Twenty-six essays were submitted, and a selection of six of these is published as the major portion of the November issue of the *British Journal for the Philosophy of Science*. The subject is considered from various points of view, the competitors having been asked to "clarify the logical, theoretical and observational aspects of the idea of assigning a quantitative age to the Universe". Naturally the essays vary in the distribution of emphasis between these aspects, and in those published the evidence most relied on ranges from the almost entirely logical to the equally one-sided observational kind. The value of the publication as a whole is thus greatly enhanced, and one receives the impression that the editors have made a wise choice of contributions for the enlightenment of those who wish to obtain as comprehensive a view as possible of the whole problem

The particular solutions arrived at, which are quite properly advanced with caution, differ considerably, but these are of less significance than the arguments that lead up to them The essays should therefore be read in full if the greatest benefit is to be derived, but an indication of the conclusions may be of some interest M Scriven (Minnesota), from epistemological reasoning, concludes that "no verifiable claim can be made either that the Universe has a finite age or that it has not We may still believe that there is a difference between these claims but the difference is one that is not within the power of science to determine, nor will it ever be" J T Davies (London) provisionally accepts the age (about 4 × 10^9 years) given by linear extrapolation from the nebular recession hypothesis as being "the simplest interpretation of the observations and as being in excellent numerical accord with the age from independent investigations" of particular constituents of the universe E J Opik (Armagh) accepts the agreement (in general order of magnitude) of the ages given by various phenomena as suggesting an age not exceeding 6 × 10^9 years for the universe "in its present form and content" G J Whitrow (London) also lays stress on this agreement, which "strongly suggests that the universe has a finite age of some 4,000 million years" R Schlegel (Michigan) prefers the view that the universe is "atemporal"—that is, the concept of time is inapplicable to it as a whole He distinguishes this from the view that the age of the universe is infinite, for this would be a particular solution for a universe to which the time concept is applicable B Abramenko (Mannheim), though admitting that conclusions must be based on observational evidence which at present is inadequate to settle the matter finally, favours the view that time, like space, is curved, so that physical processes occur in cycles There is then no such thing as the age of the universe as a whole, and the indications of age from the various phenomena relate to the length of one cycle in the infinite succession of cycles Unlike most of the writers, however, he attaches more significance to the differences between these indications than to their agreement

All the more prominent systems of cosmology—general relativity, kinematical relativity, the 'steady state' theory involving continuous creation—are given some attention, but it is noteworthy that none of the essayists writes specifically from the point of view of any of them, indeed, the objective character of the approach throughout is a praiseworthy feature of the collection One point, however, would repay further elucidation More than one writer is evidently under the impression that, in the 'steady state' theory, nebulæ are assumed continually to pass out of the region of possible observation, at a finite distance from the observer, through attaining and surpassing the velocity of light Recent correspondence in *The Observatory* (74, 172, August 1954), however, suggests that this may be a misreading, notwithstanding that it is the apparent purport of the papers in which the theory was originally presented, and that in fact the theory assumes that the region observable in principle is infinite in extent, no nebula ever disappearing from it It is very desirable that some clear statement on this point should be made by the authors of the theory, to prevent further misunderstanding

ROYAL OBSERVATORY, CAPE OF GOOD HOPE

REPORT FOR 1953

THE report for 1953 of the Royal Observatory, Cape of Good Hope*, shows that an extensive programme of painting and repairs to the Observatory has been carried out, and dilapidations which accumulated during the war period have been practically overcome Redecorations, externally and internally, have been effected in a number of buildings and at the time of writing the report only the new office buildings, a residence and a few other minor items required attention In addition, electrical work has been carried out in some of the residences, a few extra trees have been planted, and it is hoped that a new hedge planted near the entrance gates will eventually provide some protection from the prevailing south-east wind

The reversible transit circle has been in regular use and has required little special maintenance, observations were made with it on 155 days, 187 evenings and 113 mornings The fitting of modern roller and thrust bearings to the declination axis of the Victoria telescope was completed in January, and the new cell made by Messrs Cox, Hargreaves and Thomson for the 24-in lens was then installed, this cell has resulted in a marked improvement in the performance of the lens A number of alterations have been made in other ways, among which may be mentioned the replacement of the old windscreen by a new all-canvas screen which allows observations to be made within a few degrees of the horizon instead of 30° as with the previous arrangement The telescope was used on fifty-seven nights for photoelectric observations, sixty-one nights for direct photography, and the astrometric camera that is mounted on it on forty-two nights The astrographic telescope, which was in continuous service, was used on one hundred and sixty-five nights for photoelectric photometry, on five nights for direct photography and on forty-eight nights for photography with the photometric cameras mounted on it This telescope, while still behaving fairly well in spite of its age, requires a thorough overhaul in its drive and clamping mechanism, and, in addition, the axles and bearings of the wheels carrying the dome are badly worn and will shortly need renewing

The 7-in telescope and the tower telescope have been used for observing occultations, and the former has also been used for visitors The tower telescope is not in good condition as the old stand is unsteady, and the lens requires repolishing The 6-in telescope has been in regular use for observing long-period variable stars, and has also been used for visitors and for observing occultations The photoheliograph has been used to take two photographs daily of the sun The camera is in fair condition, but the stand is old, the polar axis unsteady and the clock drive unreliable A few minor adjustments and alterations were necessary on the photometric cameras mounted on the astrographic telescope in November 1952, and the timing device was completed and brought into use The astrometric (or wide-angle lens) camera which was dismounted from the astrographic telescope in 1952 was mounted on the Victorian telescope when the work on the declination axis had been completed, and was used on forty-two nights during 1953.

---

* Report of Her Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the Year 1953 Pp 11 (Cape of Good Hope Royal Observatory 1954)

Many other matters are dealt with under the following headings observations and reductions, stellar photometry, Radcliffe section, meteorological observations, publication of results, personnel establishment, and miscellaneous Under the first of these is included an account of the parallax programme, and, although the observations for the main part of the parallax programme were completed in 1951, a few extra plates were needed to complete the determination of the proper motions in declination. Since the start of the programme in 1926, the parallaxes of 1,792 stars have been determined, while 3,508 plates are waiting to be measured for parallax and a few hundred for proper motion. Parallaxes were derived for thirty-two stars, none of which had a parallax previously derived at the Cape. Under the heading of stellar photometry is included work on bright stars, and reference is made in this to the new bright star programme which includes all stars in the Yale Bright Star Catalogue between dec −4° and −64°, together with a number of fainter stars from the radial velocity and parallax lists. Observations are being made in two colours with the photoelectric photometer attached to the astrographic refractor The stars used in the previous programme, that is, those brighter than *HR* 5 0, are used as standards, observations being made, as previously, at 30° zenith distance Under the heading of miscellaneous, Dr. R H Stoy, H M Astronomer at the Cape, refers to his two short trips overseas, the first to attend the conference on the co-ordination of galactic research, which was held at Groningen, and the second to attend two conferences in the United States, one being on photoelectric photometry, and the other on astrometry. "These three conferences," remarks Dr. Stoy, "relating as they did directly to the work of this Observatory, proved to be very helpful in suggesting the most useful programmes for future work."

THE FUNCTION OF HYDROXYPROLINE IN COLLAGENS

By Dr. K. H. GUSTAVSON

Swedish Tanning Research Institute, Stockholm

Introduction

THE degree of intermolecular and interfibrillar stability of collagen to hydrothermal influence, that is, its resistance to heat in the fully hydrated state, is most conveniently measured by the temperature at which instantaneous shrinkage of the collagen fibres takes place (thermal shrinkage) In earlier investigations, it was found that the shrinkage temperature, T_s, of collagen from fish skin (Teleostei) is much lower than that of mammalian collagen, specimens of cod fish and of bovine skin mainly being investigated. Thus, native collagen of cod fish skin shrinks at temperatures of about 40° C. [1,2], when freely suspended, whereas bovine skin requires temperatures of about 65° C. For collagen of the skin of eel and freshwater fishes from Swedish lakes, T_s w found to be in the range 55–57° C. [2]. Regardin the hydrothermal stability of the corium, th fishes form two distinct groups (1) the col and deep-water fishes for which T_s of their sk is in the range 37–45° C , and (2) the warm- an surface-water fishes with values of 50–57° C During the past fifteen years, the shrinkage tem peratures of a large number of skins from variou species of salt- and fresh-water fishes in Swedis waters have been determined[1–7] Independentl Takahashi and Tanaka[8] have determined the shrinl age temperature of skin collagen from a great numb of fishes in Japanese waters, and they also find th values to fall into two distinct temperature-ranges

Earlier Findings

It was suggested in the early work on cod fis collagen[1,2,4], at a time when data for the amino-ac composition of mammalian collagen were far fro being quantitative and no reliable analysis of th amino-acid make-up of fish collagens was availabl that the marked difference in hydrothermal stabilit of bovine skin and cod-fish skin was probably n due to different chemical composition (amino-acid but rather was a problem of different intermolecula stabilization of the two main classes of collage Thus, in the final analysis, it should be a question molecular architecture and organization.

The following differences in chemical behaviour the collagens of skins of mammals and teleost (*Gadus*) have been found earlier[1–7,9–12] Collagen fish skin is more easily gelatinized than that mammalian skin. The former is also more extensivel degraded and solubilized by acids and alkalis and b trypsin than native bovine skin[1,2], which is prac tically unattacked by trypsin[13,14]. Thermal de naturation of fish collagen does not increase it reactivity towards large molecules, mainly inte acting with proteins by means of co-ordinate valenc forces (hydrogen bonding), for example, vegetab tannins, while the fixation of these agents by collage of bovine origin is drastically increased by denatur tion of the protein[4–7]. The reactivity of agen principally reacting with proteins by means electrovalency is practically identical for both typ of collagen, native as well as denaturated[4–7]

Irreversibly fixed polyacids show distinctly d ferent effects on the two types of collagen T bovine type is not markedly changed, and is in som respects stabilized by these agents, whereas c skin is practically destroyed by irreversible upta of the polyacids, T_s is much decreased and the fib strength is completely lost[9]. Additional characte ization has been obtained from investigations of t effect of anionic detergents such as sodium dodec sulphate in 5 per cent aqueous solution Cod sk was largely solubilized, whereas no permane alteration of bovine skin was found in these trea ments The unifunctional, non-swelling naphthalen β-sulphonic acid and polymetaphosphoric acids sho the same differences in their action on the two for of collagen[10]

In view of these observations and the fact that t acid- and alkali-binding capacities of the two typ of collagen were identical, it was suggested that t difference between the bovine and teleost (cod fis collagens should be principally one of molecul organization, the low degree of stability of t fish-skin collagen being ascribed to a less develop

MEDICAL RESEARCH COUNCIL

The Use of Trilene by Midwives

BY THE COMMITTEE ON ANALGESIA IN MIDWIFERY

This Memorandum describes clinical trials to ascertain whether Trilene was a safe and effective analgesic agent for use by unsupervised midwives

Memorandum No 30 2*s* (2*s* 1½*d*) [50*c*]

In the press

Indices of Heat Stress

BY F E. SMITH

This report of the advantages and disadvantages of two different indices of warmth will interest all concerned with the wellbeing of workers in hot conditions

Memorandum No 29 2*s* (2*s* 1½*d*) [50*c*]

Prices in brackets include postage, dollar prices are post free in the U S A

HER MAJESTY'S STATIONERY OFFICE

P O Box No 569, London, S E 1, Edinburgh, Manchester, Birmingham, Cardiff, Bristol, Belfast, or through any bookseller, and from British Information Services, 30, Rockefeller Plaza, New York 20, U S A

OOKS–NEW AND VALUABLE

LAYTON'S THE THEORY OF EMULSIONS AND THEIR ECHNICAL TREATMENT
Fifth Edition By C G SUMNER, Ph D, F R I C
98 Illustrations 72s

RACTICAL PHYSIOLOGICAL CHEMISTRY
By P B HAWK, Ph D, BERNARD L OSER, Ph D, and W H SUMMERSON, Ph D
New (Thirteenth) Edition 307 Illustrations, 5 Coloured Plates
Just ready 85s

HE CHEMICAL ANALYSIS OF FOODS
By H E COX, Ph D, D Sc, F R I C *Fourth Edition* 39 illustrations 28s

ILS, FATS AND FATTY FOODS
eir Practical Examination (Bolton and Revis)
Third Edition By K A WILLIAMS, B Sc, Ph D, F R I C
8 plates and 40 text-figures 63s

ARNISHED CLOTHS FOR ELECTRICAL INSULATION
By H W CHATFIELD, Ph D, B Sc, F R I C, and J H WREDDEN, F R M S
60 Illustrations 21s

HE PLANT ALKALOIDS
By T A HENRY, D Sc
Fourth Edition 63s

TEXTBOOK OF PHARMACOGNOSY
ructural and General
By T E WALLIS, D Sc, F R I C, Ph C
Second Edition 226 Illustrations 35s

by the same author

RACTICAL PHARMACOGNOSY
Sixth Edition 72 Illustrations 18s

HEMISTRY AND BIOLOGY OF PTERIDINES
Ciba Foundation Symposium
143 Illustrations and Diagrams *Just ready* 42s

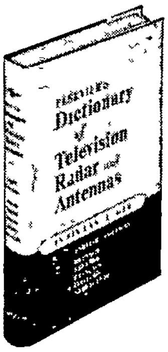
iba Foundation COLLOQUIA ON ENDOCRINOLOGY
ol VIII The Human Adrenal Cortex
Ready this month About 45s

iba Foundation COLLOQUIA ON AGEING
ol I General Aspects
Illustrated *Ready March*

J. & A. CHURCHILL LTD.

04 GLOUCESTER PLACE, LONDON, W.I

★ *The first of Elsevier's superb*



MULTILINGUAL

Technical Dictionaries

Television

Radar-Antennas

• 6

Languages

IN research, technical know-how and publicity, these meticulously edited and ingeniously arranged dictionaries offer a new and precise basis for translation This first correlates English (and American), French, Spanish, Italian, Dutch and German, and as the subject is developing, it includes brief definitions Slang and jargon are not excluded The clear layout is that indicated by UNESCO research The author is W E CLASON, Head of the Translation Dept at Philips, Eindhoven 6¾ × 9 in, 600 pp *March*, £6

★ **Rubber** (10 languages); **Automobiles** (8), **Cinema, Sound, Music** (6), **Criminal Science** (8) are among many others being prepared

CHEMISTRY—NEW AND RECENT

Liquid-Liquid Extraction—Alders

A guide to extraction calculations, and their theory, to the measurements required, and to small-scale operations designed to forecast results, whether for research or in industry From the Shell labs, Amsterdam *Feb*, 32*s*

Solvents Manual & Chart—Marsden

First reviews tend to confirm this as the most lucid, easily-used reference on significant solvents ever compiled 70*s* The ingenious *Solubility Chart* also in a wall version, 12*s*

Theoretical Organic Chemistry

An Introduction—Hermans

The essential theory including many very recent advances, set out clearly for students with a minimum of mathematics *Just ready.* 38*s* 6*d*

Theoretical Principles of Organic Chemistry—Huckel

The long-awaited English version of **PROF HUCKEL'S** great work is a sound and stimulating guide to a vast field, from the modern viewpoint which he himself has done so much to establish Vol I (of 2), *March*, 77*s* 6*d*

Experimental Inorganic Chemistry

DODD-ROBINSON with its modern methods, interesting preparations and 1,500 references has been welcomed everywhere, especially for research labs 42*s*

Chemical Constitution—Ketelaar

This *Introduction to the Theory of the Chemical Bond*, by the Professor of Physical Chemistry at Amsterdam, is strikingly up to date, and stimulating to teacher, student or practising chemist 40*s*

Synopses, and new 54 pp Catalogue from
CLEAVER-HUME PRESS, LTD
London 31 Wright's Lane, Kensington, W 8

INORGANIC QUALITATIVE ANALYSIS:

SEMI-MICRO METHODS

BY

H • HOLNESS

M Sc, F R I C, Senior Lecturer in Chemistry, South-West Essex Technical College

This is an essentially practical book to be used "on the bench" The whole work has been thoroughly tested in practice and every experiment described has been tried out with classes of students All students, up to and including those sitting for the B.Sc general examination in chemistry for London University, will find this a valuable book Illustrated 12*s* 6*d*

PITMAN

Parker Street . Kingsway London, W C 2

The SCIENTIFIC BOOK SUPPLY SERVIC

(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

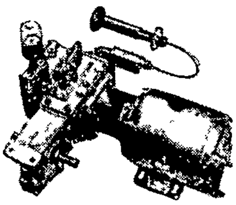
Specialists in Scientific Books & Periodicals

PHONE CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

INFINITELY VARIABLE SPEED

Hydraulic Gears at less than 15% of original cost



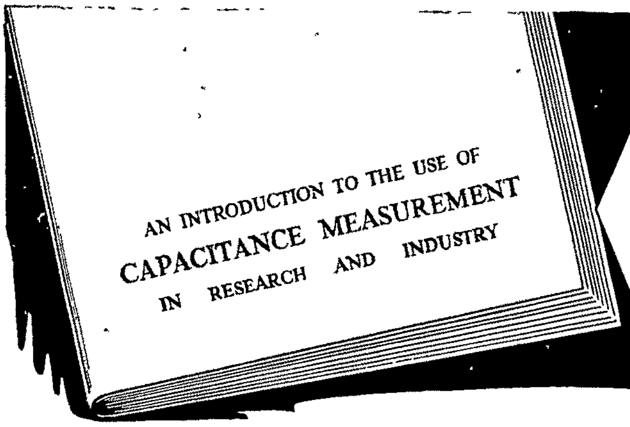
Unit illustrated ½ H P Brook Gryphon Motor, 5 1 Croft Worm Reduction Gear, both flange-mounted to the Transmission, which is fitted with hydraulic (remote) control (Output speed 0-174 r p m max torque 450 lb in)

Write for full details

Illustrated brochure and long list o famous users sent by return Originall made by Vickers-Detroit at over £230 Each unit transmits up to 2 B H P Zer to 1,240 r p m in either direction Si months' guarantee Units now als supplied complete with electric motors starters, remote controls, reduction gears etc, if required

N J. TATHAM & CO. LTD

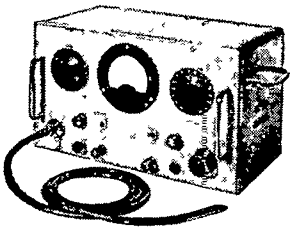
(Dept 6) . Lowfield Works • Haywards Heath • Susse



This 28 page booklet—

with sketches and data, which has been produced by our Technical Services Dept, was compiled as an aid to users of the Fielden Proximity Meter,

but we will gladly send a copy on request to any interested research worker.



The Fielden Proximity Meter (Type PM2)

Many Fielden Proximity Meters are in use as versatile tools fo laboratory and workshop investigation of mechanical, chemical an physical phenomena which may be resolved into changes of elec trical capacitance A few examples are dimensional displacement vibrations, strains, surface irregularities, coating thicknes dielectric properties of liquids and solids, moisture content, etc

FIELDEN ELECTRONICS LTD. WYTHENSHAWE MANCHESTER

Telephone: WYThenshawe 3251 (4 *lines*). *Telegrams Humidity, Manchester.*

London Office: 21 Buckingham St, W C.2 *Telephone· TRAfalgar* 3154.

Fielden INSTRUMENTATION

MACMILLAN BOOKS

Intermediate Chemistry

Sixth Edition

T M LOWRY, C B E, M A, D Sc., F R S

Late Professor of Chemistry in the University of Cambridge

A C CAVELL, M.A, B Sc.,

Senior Science Master at Uppingham School

The main intention of this new edition of *Intermediate Chemistry* has been the re-writing of the Organic Section Several changes have been made to the Inorganic Section, and there have also been a number of other alterations to and extensions of the work, which is designed to provide a complete text-book of chemistry for Intermediate and General Certificate (Advanced and Scholarship) Examinations 18*s*

From Small Beginnings

E N. da C ANDRADE, D Sc, Ph D, LL D, F R.S

This little book is based on a series of six television talks given by Professor Andrade, and is the result of letters which were occasioned by them In it he deals with some of the experiments and thoughts behind a few simple scientific discoveries which have led to such advanced developments as the radio, the aeroplane, the motor car, and the electric lamp 3*s*. 6*d*

Semimicro Qualitative Analysis

A Course in Applied Chemical Equilibrium

EDWIN O. WIIG, Ph D, WILLARD R LINE, Ph D, and JOHN F FLAGG, Ph D

This revision of *Semimicro Qualitative Analysis*, while retaining the experimental procedures and much of the form of the earlier text, has been almost completely rewritten The theoretical section has been considerably expanded and a large number of problems of varying difficulty (with the answers to many of them) have been added The sections on special procedures for ferro- and high-aluminium alloys have been modified on the basis of student experience 25*s*

Guide for Safety in the Chemical Laboratory

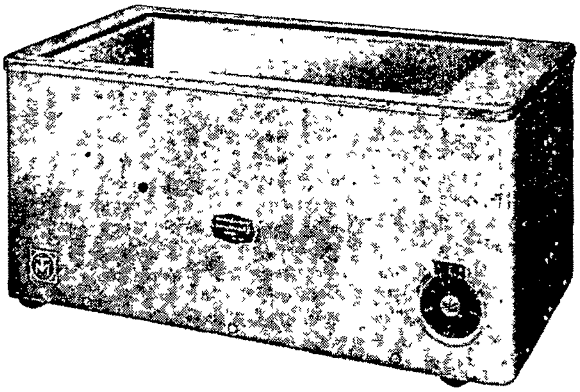
This book sets forth in detail recommended safety procedures for the storing, handling and use of chemicals in every form It is up to date in every way and covers, among other things, radioactive materials It should be kept as a guide and ready reference wherever chemicals are used 32*s*

All prices are net

St. Martin's Street, London, W.C.2

THE INCUBATING BATH

No S 771 or S 772



For really precision incubation of bacteria, etc , the normal oven is not sufficiently accurate

Many research laboratories now keep their test tube cultures in water baths when all errors due to unevenness of temperature are eliminated The speed with which the sample comes to temperature is also much greater

For this work we particularly recommend our simple baths as illustrated. They are normally in two depths and the clear internal sizes are —

23 in × 12 in × 6 in internal depth
23 in × 12 in × 10½ in internal depth
Accuracy ± 0 25°C

—FOR—"*Service, to Science*"

TOWNSON & MERCER LIMITED • CROYDON • ENGLAND

Telephone THOrnton Heath 6262

METROVICK
SCIENTIFIC EQUIPMENT

includes the following products:—

MASS SPECTROMETERS
ELECTRON MICROSCOPES
ELECTRON DIFFRACTION CAMERAS
H.V. IMPULSE GENERATORS
ROTARY VACUUM PUMPS
DIFFUSION PUMPS
VACUUM GAUGES & RELAYS
IONISATION & PIRANI TYPES
VALVES & OTHER VACUUM COMPONENTS

LINEAR ACCELERATORS
SYNCHROTRONS, BETATRONS and CYCLOTRONS
LABORATORY ELECTROMAGNETS
H.V. LABORATORY EQUIPMENT
COMPLETE VACUUM PLANTS
HIGH-SPEED RECURRENT WAVE FORM MONITOR
S. BAND TEST BENCH
S. and X. BAND SPECTROMETER

METROPOLITAN-VICKERS
ELECTRICAL CO LTD • TRAFFORD PARK • MANCHESTER 17

N/R 40

Member of the A E I group of companies

NOW COMPLETE

The Proteins

CHEMISTRY, BIOLOGICAL ACTIVITY, AND METHODS

Edited by HANS NEURATH, University of Washington, and KENNETH BAILEY, University of Cambridge

Volume I, Part A

1953, 548 pp., illus., 96s.

The Isolation of Proteins
By John Fuller Taylor

The General Chemistry of Amino Acids and Peptides
By P. Desnuelle

The Amino Acid Composition of Proteins
By G. R. Tristram

The Structure and Configuration of Amino Acids, Peptides and Proteins
By Barbara W. Low

Optical Properties of Proteins
By Paul Doty and E. Peter Geiduschek

Electrochemical Properties of the Proteins and Amino Acids
By Robert A. Alberty

Volume I, Part B

1953, 567 pp., illus., 104s.

The Size, Shape and Hydration of Protein Molecules
By John T. Edsall

Protein Interactions
By Irving M. Klotz

Protein Denaturation
By Frank W. Putnam

The Chemical Modification of Proteins
By Frank W. Putnam

The Relation of Chemical Structure to the Biological Activity of the Proteins
By R. R. Porter

Author Index—Subject Index for complete Volume I.

Volume II, Part A

1954, 661 pp., illus., 112s.

Nucleoproteins and Viruses
By Roy Markham and J. D. Smith

The Oxidizing Enzymes
By Thomas P. Singer and Edna B. Kearney

Respiratory Proteins
By Felix Haurowitz and Richard L. Hardin

Toxic Proteins
By W. E. Van Heyningen

Milk Proteins
By T. L. McMeekin

Egg Proteins
By Robert C. Warner

Seed Proteins
By Sven Brohult and Evald Sandegren

Proteins and Protein Metabolism in Plants
By F. C. Steward and John F. Thompson

Protein Hormones
By C. H. Li

Volume II, Part B

Dec. 1954, 756 pp., illus., 132s.

Interstitial Proteins: The Proteins of Blood Plasma and Lymph
By Walter L. Hughes

The Proteins of Immune Reactions
By William C. Boyd

Structure Proteins. I.
By J. C. Kendrew

Structure Proteins. II. Muscle
By Kenneth Bailey

Proteolytic Enzymes
By N. Michael Green and Hans Neurath

Peptide and Protein Synthesis. Protein Turnover
By H. Tarver

Author Index—Subject Index for complete Volume II.

Academic Press Inc., Publishers
125 East 23 Street, New York 10, N.Y., U.S.A.
British Office: ACADEMIC BOOKS, LTD.,
129 Queensway, London, W.2.

A NEW-PRINCIPLE A-C AUTOMATIC VOLTAGE STABILISER

We have now had released to us by a Government Department th design of our "A.C. Mains Regulator, Automatic, Step, Mark II", an are therefore manufacturing this unit for general sale. It ideally fills th need for a cheap, small and light Stabiliser. Although it measures onl 8¼in. x 4½in. x 5in., weighs as little as 11 lbs., and costs only £24 ne it has a performance fully equal to any similarly rated Automati Stabiliser of the resonated, saturated core type, without any of th disadvantages.

ASR-1150 has a pure output waveform, is unaffected by changes i mains frequency, and works equally well from no-load to full loa which is 1150 VA. It has a stabilised output at 230V unless otherwis ordered.

Many other Automatic Voltage Stabilisers are now manufactured b us, and all are available for immediate delivery. In some cases th constancy of output is as high as 0.15%. Models are available fror 200 VA to 30 kVA, single phase. 3-Phase Stabilisers are also availabl Prices are *extremely* competitive.

We can supply from stock all types of American tubes, condensers, valves, potentiometers, etc.

★*MEMO: If you are interested in infinitely-variable Transformers, do not forget the almost indispensable "VARIAC" (Reg'd. Trademark). Models are available from 170 VA to 21kVA. Our Catalogue V-549 (3rd Edition) tells the whole story, and will gladly be mailed free and post free, on request.*

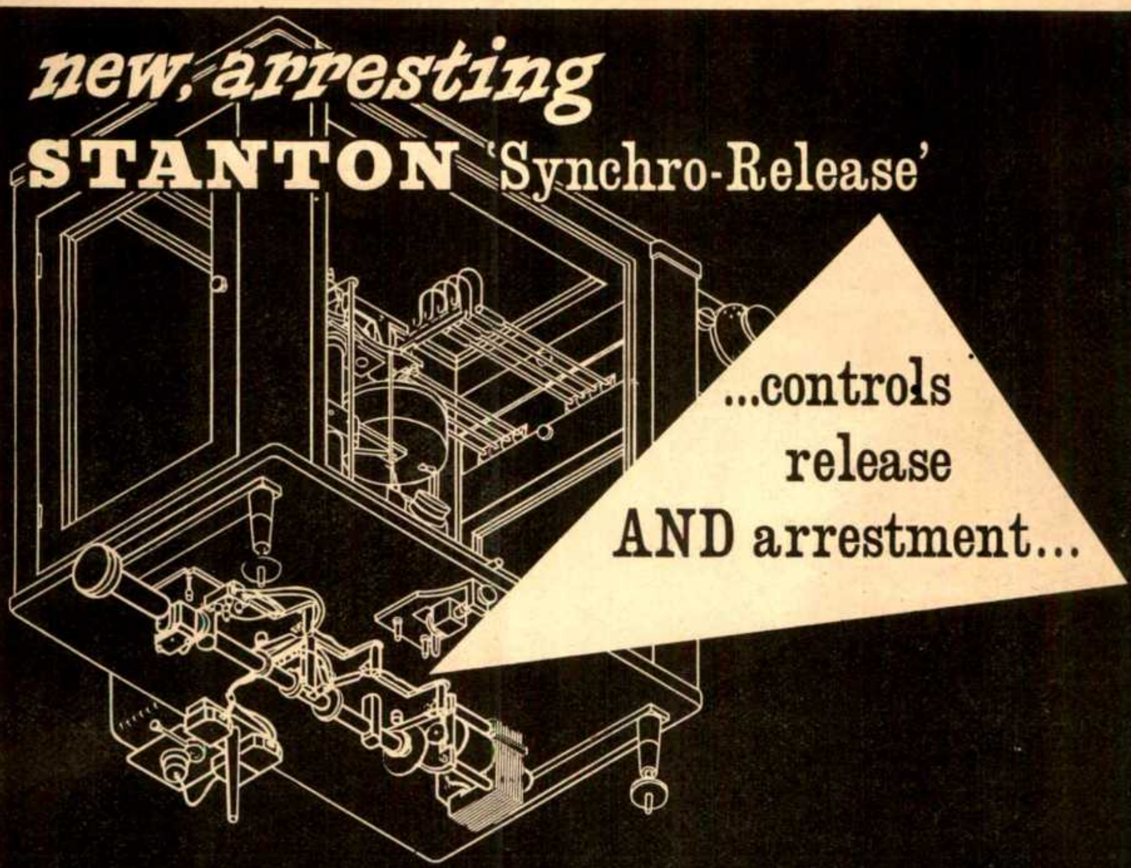
The *NEW "ASR-1150"* costs only *£24* net

Complete information is obtainable from:

CLAUDE LYONS LTD.,
Electrical and Radio Laboratory Apparatus, etc.
Head Office and Works: 76, OLDHALL STREET, LIVERPOOL 3, LANCS
SOUTHERN FACTORY: VALLEY WORKS, WARE ROAD, HODDESDON, HERTS
(A.10 MAIN LONDON/CAMBRIDGE ROAD, AT JUNCTION OF A.602

new, arresting

STANTON 'Synchro-Release'



brings knives and bearings smoothly into contact without impact -independently of the user

The most careful chemist could not release a balance more smoothly than the Stanton "Synchro-Release" device. So gently controlled is the automatic motion of the "Synchro-Release" mechanism that knife edges and bearings are brought into contact swiftly, safely, accurately, without the slightest jarring or vibration of impact no matter how hurried or unskilled the operator may be.

ALL Stanton balances can now be supplied with "Synchro-Release" giving these extra advantages:—

- **Safely controls arrestment as well as release.**
- **No loss in weighing time.**
- **Ensures sustained accuracy on routine weighings.**
- **Simple, sturdy synchronous device—nothing to go wrong.**
- **Facilitates training of laboratory personnel.**
- **Reduces balance operating costs.**

SEND TO-DAY *for illustrated leaflet giving full details of this amazing new improvement.*

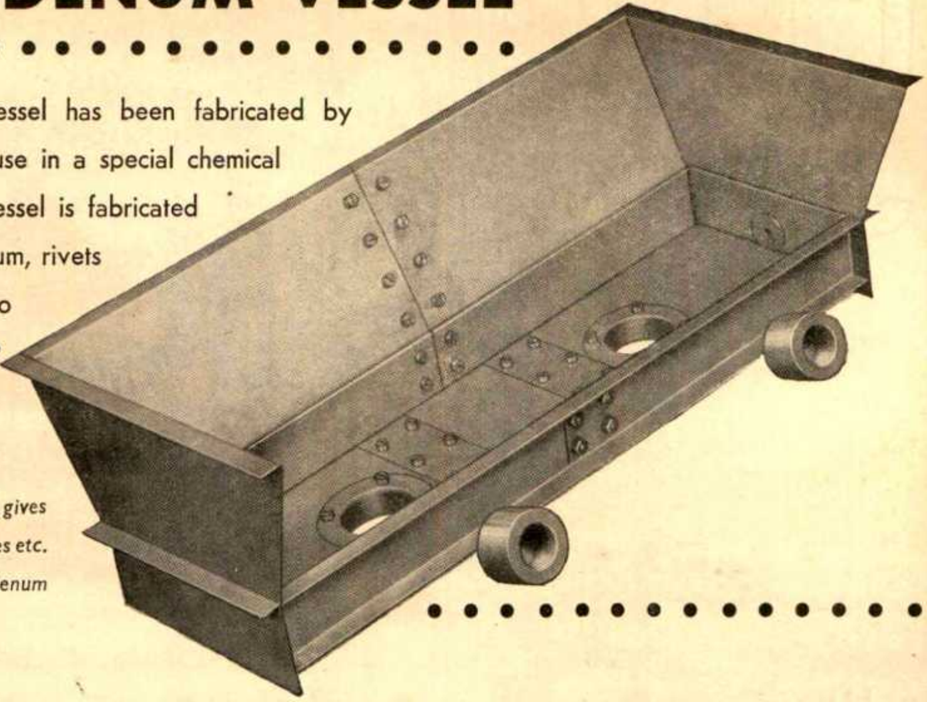
STANTON
precision balances

Please send me a free copy of "Contact without Impact."
STANTON INSTRUMENTS LTD., (DEPT. N.3.)
119 OXFORD STREET, LONDON, W.1.
Name ....
Address ....
....

MOLYBDENUM VESSEL

This molybdenum vessel has been fabricated by Murex Limited for use in a special chemical plant. The whole vessel is fabricated entirely in molybdenum, rivets and screws being also of this metal.

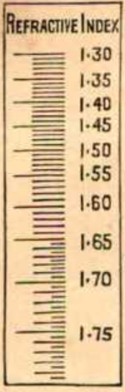
Write for Booklet PII which gives details of physical properties etc. of Tungsten and Molybdenum materials.

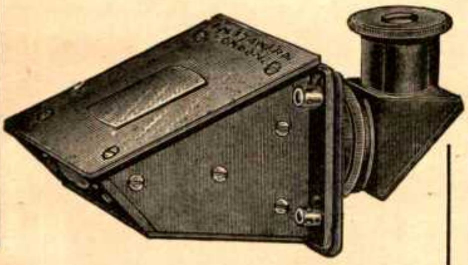


MUREX LIMITED · *(Powder Metallurgy Division)* RAINHAM · ESSEX · *Rainham, Essex* 3322
LONDON SALES OFFICE: CENTRAL HOUSE, UPPER WOBURN PLACE, W.C.1. · *Euston* 8265

THE HERBERT SMITH REFRACTOMETER

For determining the Refractive Indices of Gem Stones and Minerals. The Scale gives the Indices without calculation to ·01 and by estimation to ·001. The instrument will take either large or small specimens.





The Herbert Smith Refractometer in case, complete with instructions **£25 0 0**

Dichroscopes, Hardness Points, Pocket Lenses, etc.

J. H. STEWARD, LTD.
Established 1852
406 Strand, London, W.C.2
Phone: TEMple Bar 1867

PRESS for making KBr and KCL DISCS
as used in I-R and U-V solid state study.

INFRA-RED CELLS
Variable path-length cells for liquids.
Fixed path-length cells for liquids and gases.
Descriptive Catalogue CH388/N11 free on application

HILGER & WATTS LTD.
98 St. Pancras Way, London, N.W.1

Official repairing agents in Great Britain for
Carl Zeiss of Jena
and
Bausch & Lomb, U.S.A.

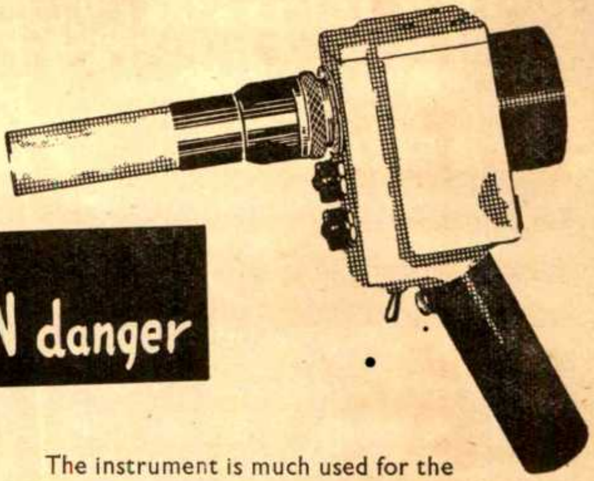
C&P

SPECIALISTS IN MICROSCOPE REPAIRS
ALL BEST MAKES
We manufacture replacement spares, if practicable

B. COOK & S. PERKINS
Pembroke Works, Pembroke Rd., Muswell Hill, London, N.10
Telephone: **TUDor 9731-2-3**

STATIC

an UNSEEN danger



The Statigun measures potential gradient in air over the range 0-300kv/ft. Attachments enable insulation resistance up to 10^{13} ohms and surface charge density up to 3×10^{-9} coulombs/cm^2 to be measured.

The instrument is much used for the investigation of static charges in the textile, plastics, paper, rubber and explosives industries as well as in hospital operating theatres. Further details are given in leaflet No. F.123 available on request.

BALDWIN *scientific instruments*

BALDWIN INSTRUMENT COMPANY LTD. DARTFORD KENT • TEL. 2948

★ ★ ★ ★ ★ **GRATICULES** ★ ★ ★ ★ ★

★ **PRECISION PHOTOGRAPHY** ★

★ **MEASURING SCALES** ★

★ **DIVIDED CIRCLES** ★

★ **SEGMENTS** ★

★ **ARCS** ★

★ ★

★ ★

★

Paton Hawksley

Rockhill Laboratories • Keynsham • Somerset

For scientific electronics...

In its most advanced form, specialised production in electronics today calls for the combined skill, knowledge and experience of a diversity of scientists and technicians and may employ a similar diversity of resources at the stage of physical interpretation, if the sum of this intelligence is to result in the most efficient end product.

Plessey number all these facilities, and many others, as closely integrated parts of a single division — the Electronics Division — and are, in consequence, able to offer a rare if not unique service to manufacturers for the limited or quantity production of their products.

Among those renowned organisations which have current contracts with Plessey are included BTH, Decca, IAL, Kelvin Hughes, Marconi's Wireless Telegraph Company Ltd., and Laurence Scott & Electromotors Ltd.

... quantity or specialised production by

Plessey

ELECTRONICS DIVISION
TELEPHONE: VALENTINE 8855
THE PLESSEY COMPANY LIMITED
ILFORD · ESSEX

PE5

Stop Watches

OUR improved model 308 stop-watch is now available for delivery from stock. The watch is specially timed at the factory to conform with the requirements of the Ministry of Fuel and Power (Elec. Supply Meters Act, 1936) and the requirements of the N.P.L. for a high grade stop watch with a 1/30th second escapement suitable for laboratory use.

The dial is calibrated 0-10 mins., the large hand making 1 revolution in 10 secs. The size of the watch, 22 ligne, with a dial diameter of 1¾ in., allows the use of a very open scale thus facilitating the reading of the sub-divisions which are graduated 1/20 sec.

Black or white dials are available and we are prepared to luminise the hands and figures to special order.

A comprehensive range of stop-watches is available for all purposes.
A copy of our new illustrated catalogue will be gladly sent on request.

Guaranteed repairs. Timing service. Certification

CAMERER CUSS
Timing Division
Makers of Good Clocks & Watches since 1788.
AT
NEW OXFORD STREET, LONDON, W.C.1
MUSeum 8968/9.
Our only other address, 91 Kingsway, W.C.2

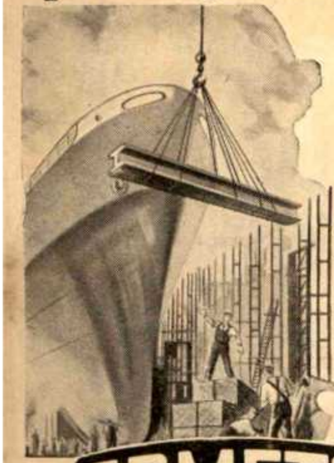
FOR pH CONTROL

JOHNSONS OF HENDON offer to chemists and manufacturers this useful series of five test papers for the measurement of pH values. UNIVERSAL is one paper covering completely the range from pH 1 to pH 10, enabling pH values to be checked to within 0.5 pH. COMPARATOR test papers make a set of four separate indicators for obtaining still greater accuracy by determining the pH value of any solution to within 0.3 pH.

Descriptive leaflet will be sent free on request.

JOHNSONS OF HENDON LTD.
LONDON, N.W.4 ESTABLISHED 1743

Upholding Britain's Name in Engineering



The words "British-built" have always implied the highest traditions in skill and material. That is why engineers, in maintaining these standards, consistently specify Ermeto Valves and Couplings. Patented throughout the world, they are unsurpassed for their supreme pressure tightness and vibration-proof qualities. The secret is in the Ermeto ring which cuts its own sealing flange as you tighten the locking nut.

Ermeto joints have no equal.

ERMETO VALVES & COUPLINGS

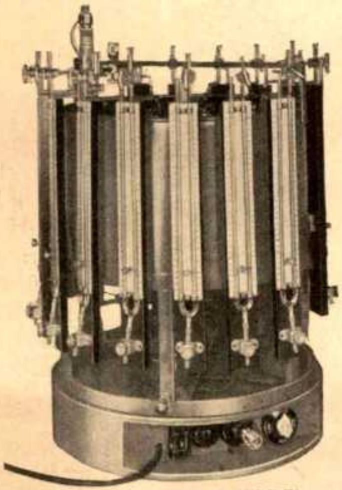
Regd. Trade Mark

BRITISH ERMETO CORPORATION LTD.,
Maidenhead, Berks, England Telephone: Maidenhead 2271/4

HOSLAB
Regd. Trade Mark
Laboratory Equipment

WARBURG CONSTANT VOLUME RESPIROMETER

(LEAFLET ON APPLICATION)



CIRCULAR BENCH MODEL
RECTANGULAR MODEL ALSO AVAILABLE

HOSPITAL AND LABORATORY SUPPLIES LTD.
12 CHARTERHOUSE SQUARE, LONDON, E.C.1
COMPLETE LABORATORY FURNISHERS

"Finger-tip flame control"

said a silversmith, "Pleasant to handle, very sensitive controls."
He was one of the many users of our Flamemaster Mark II and the three comments he made probably sum up the main reasons for the Flamemaster's immense popularity.
Also:

It burns coal-gas or bottled-gases of the butane type with equal efficiency . . .
The air or oxygen pressure needed is comparatively low . . .
All the different flame-units are easily interchangeable . . .
It won't splutter or give you an unstable flame . . .
It won't leak, even on high pressures . . .
It won't raise your running-costs, (our economiser-trigger sees to that) . . .
But it *will* bring speedy and reliably controlled heating right to the spot where you need it . . .

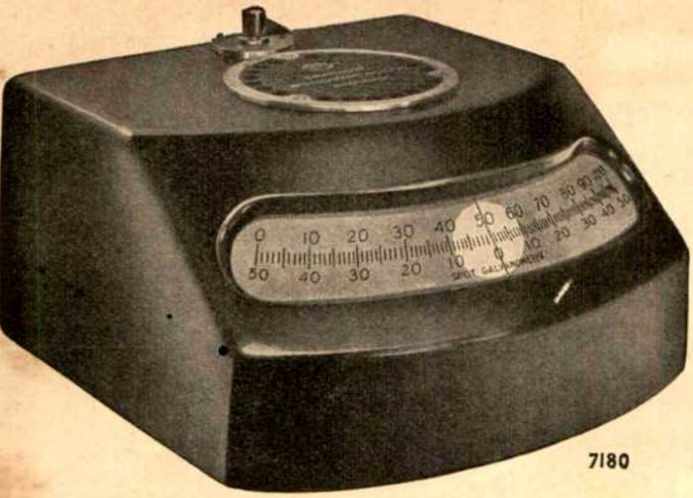
remember the name

FLAMEMASTER MARK II

Write for full details to :—

STONE CHANCE LIMITED

DEPT. F.12, LIGHTHOUSE WORKS, SMETHWICK 40, BIRMINGHAM.
TELEPHONE: BROADWELL 2651.
LONDON OFFICE: 28 ST. JAMES'S SQUARE, S.W.1. TEL: WHITEHALL 6002.



CAMBRIDGE SPOT GALVANOMETER

THIS self-contained reflecting galvanometer is complete with scale, lamp and lamp transformer. The scale is linear, and may have either centre- or end-zero. Readings can be taken to 0·2 mm.

A self-contained 4-range shunt can be fitted if desired, giving powers of × 1, × 10, × 100 and × 1000.

May be operated from MAINS or BATTERY

Resistance (Ohms)	Scale Length (mm.)	Sensitivity mm. on scale per μA	Period (secs.)	External Resistance to give critical damping (Ohms)
20	160	19	2	150
50	160	30	2	500
450	160	170	2	14,000

May we send you

SHEET 271-N?

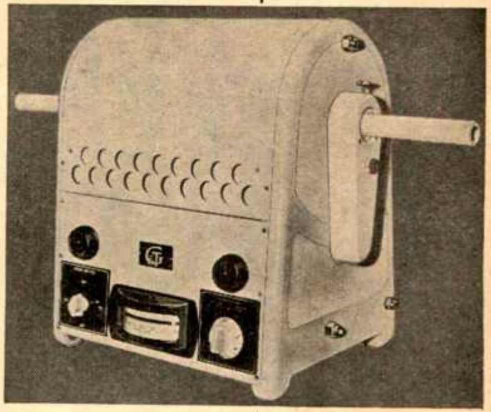
CAMBRIDGE
INSTRUMENT CO. LTD.
13 GROSVENOR PLACE, LONDON, S.W.1
WORKS: LONDON & CAMBRIDGE

G & T HEAVY ELEMENT TUBE FURNACE

- **ELEMENT SPEEDILY AND EASILY REPLACED**
- **SIMMERSTAT CONTROLLED**
- **BUILT-IN PYROMETER AND INDICATOR**
- **TEMPERATURES UP TO 1150° C.**

This modern low-voltage tube furnace with self-supporting alloy element is widely used in chemical, metallurgical, research and industrial laboratories. Its many uses include the combustion analysis of carbon and sulphur in ferrous metals, critical point and fusion point determinations and continuous wire annealing.

Please write for leaflet GT 1387



Catalogue No. B29–180

GRIFFIN & TATLOCK

(A Division of Griffin & George Ltd.)

KEMBLE STREET,
LONDON, W.C.2

STANDLEY BELCHER & MASON LTD.,
CHURCH STREET,
BIRMINGHAM, 3

19, CHEETHAM HILL RD.,
MANCHESTER, 4

45, RENFREW STREET,
GLASGOW, C.2

8, JOHNSTON TERRACE,
EDINBURGH, 1

intermolecular cross-linking of the protein chains, compared to bovine collagen[1-2]. The titration curves also showed close similarity, only with a slight deviation of the curve in the pH range 3–9, pointing to more easily discharged ionic groups (salt links) in the case of fish collagen[10].

In view of these findings, the following working hypothesis of the structural organization was advanced. Mammalian-skin collagen, with its intertwining fibre bundles, is mainly stabilized by means of hydrogen-bond bridges between laterally located keto-imide groups. Salt links of electrostatic nature probably supplement these primary cohesive forces. In fish-skin collagen, with parallel grouped layers without any marked interlacing of fibre bundles, on the other hand, the low degree of stabilization of the structure may be accounted for by the assumption that the hydrogen bonding is only weakly developed, electrovalent cross-linking being responsible for a great deal of the structural cohesion.

This finding that the irreversible inactivation of the ionic groups of fish collagen by means of non-swelling agents, specific for these groups (eliminating the electrovalent cross-links), leads to a drastic lowering of the stability and mechanical strength of the fibres would then be due to the fact that these salt links are to a great extent responsible for the cross-linking, hydrogen bonding being less developed. On the other hand, the structural properties of mammalian collagen, mainly stabilized by cross-links of the hydrogen-bond type, are not materially impaired by the elimination of the salt links by discharge, since the ionic interchain forces contribute only slightly to the molecular cohesion, the dominant cross-links being of the hydrogen-bond type, which are not involved in the fixation of the agents specific for electrovalent protein groups.

This view is supported by some additional findings: (1) The general properties and the reactivity of fish-skin collagen resemble those of bovine collagen which has been pretreated with lyotropic agents, such as concentrated solutions of urea, the main effect of which is to rupture interchain links of the type of hydrogen bonds and make sites of reaction available in the protein[4]; (2) Nutting and Borasky[15] found the electron-microscopic picture of shark-skin collagen to be similar to that of bovine collagen which had been degraded by prolonged alkali treatment (liming).

Amino-acid Composition

Further progress became feasible with the advent of complete data on the amino-acid composition of mammalian collagen[16] and of the corresponding data for fish collagen[17]. The main difference between collagen of mammals and teleosts is the low content of hydroxyproline (9 per cent) of fish-skin collagen (halibut[18], shark[19]) compared to the figure of 14 per cent for bovine collagen, apart from minor divergences in amino-acids present in small amounts, such as serine, threonine and methionine[17]. Hence, the possibility of the hydroxy group of the hydroxyproline residue being involved in the intermolecular linking of collagen is obvious[3]. The original view of the less-developed intermolecular hydrogen bonding on the peptide links of fish collagen may then have to be modified, with due attention to the possible function of the hydroxy groups in the interchain linking[3].

In view of the different hydrothermal stability of skins of warm- and cold-water fishes, their contents of hydroxyproline and proline should be of interest, particularly for ascertaining whether there exists any relation between the contents of pyrrolidine residues and the T_s of the collagens. The possible function of the hydroxyproline residue for stabilizing collagen has been suggested by Borasky[19] and the present author[3,20]. In a preliminary note on the hydroxyproline contents of mammalian collagen and of the two types of teleost collagens, such an interdependence was reported[3]. This finding has been independently verified by Takahashi[21]. On investigating skins of some fifty-odd species of fishes, Takahashi[21] found 7–9 per cent hydroxyproline in skins of cold-water fishes, with T_s in the range 34–44° C. The great majority of species contained 8 per cent. The corresponding values of the skins of warm-water fishes, with T_s 50–58° C, were 10–12 per cent. The figures for bovine hide and gelatin were 12·5 and 13·4 per cent, respectively. The lowest value of hydroxyproline, 7·0 per cent, was found for the skin of the rock-fish (*Sebastodes baramenuke*), which also showed the lowest T_s ever recorded for collagens, namely, 33–34° C. The highest values of T_s and hydroxyproline were recorded for the skin of the carp (*Cyprinus carpio*) with 57° C and 11·6 per cent, respectively[21].

The available data on the content of hydroxyproline have been obtained by the method of Neuman and Logan[18]. The accuracy and reproducibility of this method is not as great as could be desired, and since indirect values only are obtained by this technique, a direct estimation of this imino-acid was imperative. By a combination of the Moore–Stein chromatographic procedures on columns of starch[22-25] and on 'Dowex-50'[25,26], according to the modification of Åqvist[27], the contents of hydroxyproline and proline of collagens of skins from mammals and from representative species of the two main groups of Teleostei have been estimated by Dr. S. Åqvist.

Materials and Methods

Isoelectric collagen of calf-skin pelt (lightly limed for unhairing) represented the mammalian collagen. Specimens of skins of cod fish (*Gadus morrhua*) and of pike (*Esox lucius*) were selected as typical cold-water and warm-water fishes. The fish skins were not subjected to any alkali treatment. After mechanical removal of scales, adipose tissue and other non-dermal matter, the fresh skins were soaked for 24 hr. in a 10 per cent solution of sodium chloride and saturated with toluene, at 5° C, in order to remove globular and other accessory proteins. The skins were washed and drummed in cold water until free from chloride ions. The acetone-dehydrated skins were then extracted with petroleum ether and finally acetone-dehydrated. The T_s values of the skins were determined by the conventional method on freely suspended strips of both fresh and purified skins. Identical T_s values were found. Six determinations were carried out on each skin. The samples were taken from different parts of the skin, cut in dorsal and ventral directions, from six specimens. The acid-binding capacity was determined indirectly by estimating the acid removed by 500 mgm. collagen in the form of small cubes, from 10·0 ml. of 0·1 M hydrochloric acid, one-molar in sodium chloride, upon 4 hr. shaking, titrating the residual solution to pH 5.

The estimation of proline and hydroxyproline was carried out on 500 mgm. samples of skin substance,

Table 1. GENERAL CHARACTERISTICS OF COLLAGENS

No.	Type of skin	T_s in °C	Per cent total nitrogen on ash- and fat-free dry substance	Per cent ash	Acid-binding capacity in m*M* hydrochloric acid/gm. collagen
1	Cod fish (*Gadus morrhua*)	40	18.3	0.8	0.92
2	Pike (*Esox lucius*)	55	18.4	1.0	0.93
3	Calf (*Bos taurus*)	65	18.3	0.05	0.90

which was refluxed with 6 *M* hydrochloric acid for 36 hr. The first separation was on a column (300 mm. × 80 mm.) of a special starch. The column was washed with 8 litres of propanol–hydrochloric acid (1:1) and finally equilibrated with a solution of propanol–0.5 *M* hydrochloric acid (2:1). Portions of 200 mgm. protein were applied. This solution was made 0.5 *M* in hydrochloric acid and the double volume of propanol added. Hourly fractions were collected with the aid of a time-controlled fraction collector. For localization of the position and for identification of the amino-acids, the photometric ninhydrin method of Moore and Stein[22,23] was applied to 0.05 ml. of each fraction. The fractions were also located on a paper chromatogram, which is particularly useful for examination of overlapping fractions of hydroxyproline. The proline came out in fractions essentially pure after collecting 4 litres of eluate, and the hydroxyproline fractions after running 6 litres. The volume of the collected fractions of each amino-acid was about 800 ml. The hydroxyproline fractions were contaminated with threonine, and contained also smaller amounts of alanine, glutamic and aspartic acids. Therefore, a re-separation was necessary for hydroxyproline, and also for the proline in order to remove non-protein nitrogen (ammonia), due to contamination during the various operations. The collected fractions were evaporated *in vacuo* and dissolved in *M* hydrochloric acid. The final separation was on a column of 'Dowex-50', using the 'colloidal' type of 250–500 mesh, operated on the hydrogen cycle. The column was 20 mm. × 800 mm. *M* hydrochloric acid was used as eluting solvent. The resolving power of this column was excellent. Pure fractions of proline and hydroxyproline were collected in a comparatively small volume. The contents of the prolines were estimated by the micro-Kjeldahl method, since no satisfactory colorimetric methods for the prolines are available.

Data on the general characterization of the three types of skin collagen are given in Table 1. The results of the imino-acid analysis are shown in Table 2.

Discussion

General aspects. The collagen group of proteins is characterized by the prominence of proline and hydroxyproline, and the paucity of aromatic residues. Particularly the large amount of hydroxyproline is unique, and also important for the characterization of collagen as a class and for its estimation (Neuman and Logan[18], van Robertson[28-30]). The great variation of the hydroxyproline content o collagen from various sources, from 6 to 14 per cent, necessitates consideration of the origin of the collagen. Reference may be made to Bear's lucid discussion[31] on the classification of the collagen family. Further, approximately every third amino-acid residue of collagen is generally considered to be a pyrrolidine residue. This proportion is an integra part of recent models of collagen (Astbury[32], Pauling and Corey[33] and Bear[31]). Besides this regula sequence, Pauling and Corey[34] suggest occasiona units of one residue of prolines of four residue (seven 1:3 and four 1:4). The present results show that in some teleost collagens the proportion is scarcely half the number assumed.

The markedly different degree of hydrotherma stability of the skins of the two types of fishes is probably related to the different habitat, and possibly is of biological significance.

The results from investigation of numerous species of fishes show that there is a definite connexion between the hydrothermal stability and the hydroxyproline content of collagen. With decreasing percentages of this residue, the T_s of collagen is lowered, the maximum difference being more than 30 deg. C. (68° and 34°). Obviously, this is no evidence in itself for the view that the hydroxyproline residue is directly involved in the stabilization of the collagen, for example, by forming a site for an interchain hydrogen bond. The effect of the irregularity of the polypeptide chains imposed by the incorporation of the prolines may be indirect, and even fortuitous.

If collagen is mainly stabilized by interchain hydrogen bonds on oppositely located keto-imide groups of adjacent chains, the content of pyrrolidine residues should be a factor of importance. The residues of the prolines which are built into the polypeptide chains with the formation of —CO·N= links introduce a regular interruption of the normal —CO·NH— links, formed by the remainder of the amino-acid residues. Accordingly, sites for the compensation of adjacent —CO-groups of the keto-imide links are withdrawn, which implies fewer stabilizing cross-links and consequently a lowered degree of stability[35]. Then, mammalian collagen should be less stable to heat than fish collagen. However, the reverse is true.

Interchain hydrogen bond between hydroxy and keto-imide groups. On the other hand, supposing that the hydroxy groups of the residues of the hydroxyamino-acids may enter into interchain hydrogen bonding with some other groups, for example, the carboxyl, or the carbonyl of the —CO·NH— linkage, the stability of the structure would be expected to increase with the content of hydroxyproline, as is actually found[3,21].

The effect of the hydroxyproline on the degree of stability and reactivity of collagen was first examined

Table 2. PROLINE AND HYDROXYPROLINE CONTENTS OF COLLAGENS

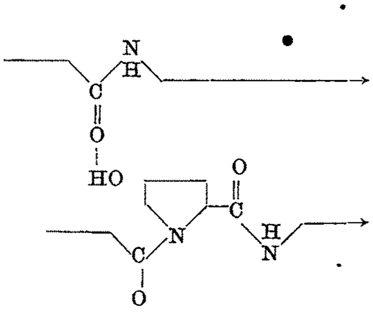
No.	Type of skin	Proline		Hydroxyproline		Proline + hydroxyproline	
		Per cent on protein	Per cent of total nitrogen	Per cent on protein	Per cent of total nitrogen	Per cent on protein	Per cent of total nitrogen
1	Cod fish	10.8	7.2	5.8	3.4	16.6	10.6
2	Pike	13.3	8.8	7.9	4.6	21.2	13.4
3	Bovine (calf)	14.1	9.5	12.7	7.4	26.8	16.9

the light of Klotz's concept[36-39], according to hich the hydroxy groups of the residues of the iphatic hydroxyamino-acids form strong hydrogen onds with the carboxyl ions in some globular roteins This linkage has been shown to affect the activity of the carboxyl ion[38] The reactions of ovine and cod-skin collagen with the simple cupric n, and with a number of complex chromium compounds, dyestuffs and non-electrolytes, have been udied in the isoelectric range of collagen The esults could not readily be reconciled with an xtension of the Klotz concept to collagens Morever, according to Bear[31], the electron-optical vidence suggests the presence of the residues of the rolines in the interbands, whereas the bands should ontain the residues of the dicarboxylic amino-acids ence, the formation of the —OH—O$\overline{\text{C}}$O— bond ppears improbable sterically

A satisfactory explanation of the correlation of the ydroxyproline content of collagens and their T_s, nd indications of the type of link formed, have been rived at by investigations of the behaviour of xhaustively acetylated bovine collagen Such a ollagen with all its amino-groups (0 39 m mol /gm ollagen) and 80 per cent of its hydroxy groups activated (1 39 m mol /gm collagen) was obtained y acetylating hide powder and calfskin, according the method of Green *et al* [40] Comparative experiments with N-acetylated collagen were included The ydrothermal stability of collagen is not affected by s N-acetylation, while the N- and O-acetylation, at is, the blocking of the hydroxy- and aminooups, lowers the T_s from 64–66° C to 40–44° C [12] his finding indicates the rupture of *interchain* oss-links by the O-acetylation.

Assuming that the aliphatic hydroxy groups are eferentially acetylated, at least 0 8 m mol. of ydroxyproline per gm collagen should have acted Hence, out of 1 07 m mol hydroxyproline sidues of the original collagen[16], three out of four ydroxy groups have been blocked. In this connexion, it is of interest to note that T_s for the acetylated bovine collagen coincides with that the skins of most cold-water fish, suggesting at the hydroxy group resisting acetylation forms stronger bond than the rest of the hydroxy oups, and further that this particular group is ainly responsible for the stabilization of the teleost llagen

From the investigations of the effect of the intivation of the hydroxy groups of collagen on its activity, the results from series with condensed getable tannins (mimosa) and non-ionic complexes sulphito–chromium sulphates are most instructive e fixation of these compounds by collagen is preciably increased by its heat-denaturation, and its pretreatment with lyotropic agents, indicating at the irreversible fixation of these compounds by llagen involves non-ionic protein groups (hydrogen nding)[4]. The mimosa tannins are mainly fixed by drogen bonding of the polyphenolic structures on e carbonyl oxygen of the keto-imide group[41,43] e very marked affinity of the condensed tannins for odified polyamides, which contain the —CO NH— kage as the principal site of binding, is the crucial oof[41] It is important to note that the non-ionic romium complexes are not bound by the polyaides[42,43]. Hence, they are probably not reacting th the keto-imide linkage of collagen Accordingly, e increased fixation of these chromium complexes heat-denaturation of collagen and by its pretreatment with lyotropic agents (urea, for example) cannot be due to the freeing of co-ordination sites on the —CO NH— linkages By O-acetylation of collagen, the irreversible binding of mimosa tannins by collagen is greatly increased, from 60 to 95–105 per cent, on the basis of protein On the other hand, the fixation of the non-ionic chromium complexes is markedly impaired by the blocking of the hydroxy groups by acetylation, decreases of the order of 30 per cent being commonly found These findings, with due regard for other facts which cannot be enumerated here, are in harmony with the view that a part of the hydroxy groups is linked by a hydrogen bond to the keto-imide group, schematically, as



The rupture of such a bond by heat denaturation, or by the lyotropic pretreatments mentioned, should satisfactorily explain both the increased fixation of vegetable tannins (by the freed —CO NH— bond) and of the non-ionic chromium complexes (by the freed OH— bond), as well as the effects of the blocking of the hydroxy group, that is, the impaired hydroxy-co-ordination of the chromium compounds, on one hand, and the increased binding of the keto-imide-attached polyphenols, on the other. The large decrease of T_s recorded ($\Delta T_s = -22$ deg. C.) is also explained. In view of the marked affinity of the native collagen for the agents mentioned, it is probable that only a few of the hydroxy and keto-imide groups are participating in this interchain cross-linking

The following considerations suggest that the hydroxy group involved is mainly furnished by the hydroxyproline residue. In the presence of an aliphatic OH group in intermolecular cross-linking, the teleost collagen should form a more stable structure than the bovine type, since the fish collagen contains more such hydroxy groups than the bovine collagen In view of the reverse trend of the shrinkage temperature, aliphatic hydroxy groups are not likely to be involved to any great extent

According to Prof R S Bear, of the Massachusetts Institute of Technology, the interchain cross-link suggested can be accommodated in the present helical model of collagen without difficulty[44]

The cross-link common to collagens generally The strong bond forming the mainstay of the collagen structure, which the masked hydroxy group is indicated to form, is probably an ester bond, the —O CO— link. The origin of the hydroxy group in this link is not known Experimental evidence for such a link in procollagen has recently been obtained by Grassmann *et al* [45] Further, the insolubility of collagen in saturated lithium bromide solution, which dissolves hydrogen-bonded structures, suggests the presence of some type of a strong bond in collagen (Alexander, personal communication) Moreover, the increase of the fixation of safranine O by collagen from 0 4 to 0 9 mgm equiv per gm collagen, found by Veis and Cohen[46] on denaturing collagen by heating it in water at 60° for 1 hr , supports this view, as does also the marked difference in alkali binding of limed collagen and gelatin, with due correction for amide groups, possibly due to the splitting of the ester bond in the alkali-processing of gelatin (Gustavson, unpublished results) As to the hydrogen bond suggested, it should be noted that, in Huggins's new collagen helix[47], the computed distance between the hydroxy group of the hydroxyproline residue and the carbonyl oxygen in the next turn of the helix is 2 9 A , indicating OHO hydrogen bonding (intrahelical)

For the direct estimation of the prolines, I am indebted to Dr S Åqvist, Karolinska Institutet, Stockholm. Research grants from Statens Tekniska Forskningsråd are gratefully acknowledged, as are also the personal communications noted in the references

[1] Gustavson, K H , *Svensk Kem Tidskr* , **54**, 74 (1942)
[2] Gustavson, K H , *Svensk Kem Tidskr* , **54** 249 (1942)
[3] Gustavson, K H , *Svensk Kem Tidskr* , **65**, 70 (1953)
[4] Gustavson, K H , *Biochem Z* , **311**, 347 (1942)
[5] Gustavson, K H , *Ing Vetenskaps Akad Handling* No 177 (1944)
[6] Gustavson, K H , *J Amer Leather Chemists' Assoc* , **41**, 47 (1946)
[7] Gustavson, K H , *Acta Chem Scand* , **1**, 581 (1947)
[8] Takahashi, T , and Tanaka, T , *Bull Jap Soc Sci Fish* , **19**, 603 (1953)
[9] Gustavson, K H , *J Soc Leather Trades' Chemists*, **33**, 332 (1949)
[10] Gustavson, K H *Acta Chem Scand* , **4**, 1171 (1950)
[11] Gustavson, K H , *J Amer Leather Chemists' Assoc* , **45**, 789 (1950)
[12] Gustavson, K H , *Acta Chem Scand* , [**8**, 1299 (1954)]
[13] Grassmann, W , *Kolloid Z* , **77**, 205 (1936)
[14] Grassmann, W , "Handbuch der Gerbereichemie", 1/1, 430 (Springer, Vienna, 1944)
[15] Nutting, G C , and Borasky, R , *J Amer Leather Chemists' Assoc* , **43**, 96 (1948)
[16] Bowes, J H , and Kenten, R H , *Biochem J* , **43**, 365 (1948)
[17] Neuman, R E , *Arch Biochem* , **24**, 289 (1949)
[18] Neuman, R E , and Logan, M A , *J Biol Chem* , **184**, 299 (1950)
[19] Borasky, R (personal communication, 1952)
[20] Gustavson, K H , Discuss Farad Soc , No 13, 234 (1953)
[21] Takahashi, T (personal communication, 1953)
[22] Moore, S , and Stein, W H , *Ann N Y Acad Sci* , **49**, 265 (1948) , *J Biol Chem* , **176**, 337 (1948)
[23] Moore, S , and Stein, W H , *J Biol Chem* , **176**, 367 (1948)
[24] Moore, S , and Stein, W H , *J Biol Chem* , **178**, 53 (1949)
[25] Moore, S , and Stein, W H , *J Biol Chem* , **192**, 663 (1951)
[26] Stein, W H , and Moore, S , Cold Spring Harbor Symp Quant Biol , **14**, 179 (1949)
[27] Åqvist, S , *Acta Chem Scand* , **5**, 1031 (1951)
[28] Robertson, van B , *J Biol Chem* , **187**, 673 (1950)
[29] Robertson, van B , *J Biol Chem* , **196**, 403 (1952)
[30] Robertson, van B , and Schwartz, W , *J Biol Chem* , **201**, 689 (1953)
[31] Bear, R S , "Adv Protein Chem ", **7**, 69 (1952)
[32] Astbury, W T , *J Int Soc Leather Trades' Chemists* , **24**, 69 (1940)
[33] Pauling, L , and Corey, R B , *Proc U S Nat Acad Sci* , **37**, 272 (1951)
[34] Pauling, L , and Corey, R B *Proc Roy Soc* , B, **141**, 31 (1953)
[35] Gustavson, K H , "Adv Protein Chem ", **5**, 353 (1949)
[36] Klotz, I M , and Urquhart, J M , *J Amer Chem Soc* , **71**, 1597 (1949)
[37] Klotz, I M , Gelewitz, E W , and Urquhart, J M , *J Amer Chem Soc* , **74**, 209 (1952)
[38] Klotz, I M , and Ayers, J , Discuss Farad Soc , No 13, 189 (1953)
[39] Klotz, I M , "Protein Interactions" in "The Proteins" (Neurath, H , and Bailey, K), 1 B, 788 (Academic Press, New York 1953)
[40] Green, R W , Ang, K P , and Lam, L C , *Biochem J* , **54**, 181 (1953)
[41] Gustavson K H , *J Polymer Sci* , **12**, 317 (1954) , *J Soc Leather Trades' Chemists*, **38**, 162 (1954) , *J Amer Leather Chemists' Assoc* , **47**, 700 (1952)
[42] Gustavson, K H , *J Amer Chem Soc* , **74**, 4608 (1952)
[43] Gustavson, K H , *Discuss Farad Soc* , No 16, 114 and 165 (1954)
[44] Bear, R S (personal communication, 1954)
[45] Grassmann, W , Endres, H , and Steber, A , *Z Naturforschung*, **9b**, 513 (1954)
[46] Veis, A , and Cohen, J , *J Amer Chem Soc* , **76**, 2476 (1954)
[47] Huggins, M L , *J Amer Chem Soc* , **76**, 4045 (1954)

ANTERIOR-PITUITARY - HYPOTHALAMIC RELATIONS IN THE FERRET

By A P. D THOMSON
and PROF S ZUCKERMAN, C B , F R S
Department of Anatomy, University of Birmingham

A WEALTH of observation has firmly establish
the fact that the anterior lobe of the pituita
gland plays a vital part in the control of growth a
reproduction, and also in several metabolic process
which cannot be classified under these two hea
On the other hand, views about the way its vario
activities are integrated and controlled remain ve
elementary They are broadly of two kinds T
first is that any specific activity of the anter
pituitary, at any given moment, is modulated by
feed-back mechanism in which the determining fac
is the level of secretion of the peripheral endocri
tissue which the pituitary gland may be stimulati
For example, as its titre in the blood rises, t
œstrogen that is secreted by ovarian tissue wh
stimulated by the anterior-pituitary follicle-stim
lating and luteinizing hormones checks the furth
secretion of FSH The second kind of explanation
that the hypothalamus directly controls certa
anterior pituitary functions An illustration of th
presumed control is the process of ovulation
animals such as the rabbit, which normally ovula
only after the stimulus of mating The immedia
cause of ovulation is the sudden release of luteinizi
hormone, and the belief is that the act of mating se
up a train of nervous stimulation which culminat
in the firing of certain hypothalamic neurons, a
that these, in turn, stimulate the anterior pituita
to discharge luteinizing hormone It has also be
suggested that the hypothalamus, by influencing t
discharge of luteinizing hormone, controls t
periodicity of the phases of the œstrous cycle
mammals in which ovulation is spontaneous
further example of this presumed hypothalan
control is the release of adrenocorticotrophic hormo
by the anterior pituitary under certain conditions
stress

Since there is reason for doubting whether t
axons of hypothalamic neurons actually innerva
the anterior pituitary gland, the view has be
advanced—and now has considerable currency—th
certain hypothalamic neurons discharge a chemi
substance which passes down their axons and diffu
into the primary capillary loops of the pituita
portal vessels, through which it passes into t
sinusoids of the anterior lobe This chemical su
stance is the presumed proximate stimulus for t
specific activation of the secretory cells in t
anterior lobe

This simple hypothesis is primarily based up
clinical and experimental observations which sh
that changes in, or stimulation of, certain regions
the hypothalamus may affect processes in which t
anterior pituitary is definitely concerned (for examp
ovulation in the rabbit). But the rest is suppositi
In the first place, there is no evidence that un
normal conditions the hypothalamus is a spec
relay station in the chain of stimulation of t
pituitary which begins, say, either with the act
mating or with a condition of stress Secondly,
the hypothalamus is a relay station, it is not kno

which nuclei are involved in the different responses of the pituitary, or by what specific nervous pathways they themselves are activated. Thirdly, no one has isolated or identified the presumed chemotransmitters which activate the anterior pituitary, and which the hypothalamic neurons are supposed to liberate; nor has any thought been given to the question whether the same degree of specificity applies to the assumed hypothalamic secretions as it supposedly does to those of the anterior pituitary. Fourthly, no proof has been given of the passage of chemotransmitters down the pituitary portal vessels. The only experimental 'proof' which has been offered in defence of the hypothesis is that certain processes in which the anterior pituitary is involved no longer occur when the pituitary gland is transplanted from its normal site, or after the pituitary stalk is effectively divided and the pituitary portal vessels have been prevented from regenerating.

The present communication is mainly concerned with the latter question, and with the part played by the pituitary portal vessels. Donovan and Harris[1] have recently described certain experiments from which they conclude that "the hypophysial portal vessels form a necessary part of the pathway of the light-induced œstrous response in the ferret". They base this view on the fact that one of six ferrets which were subjected to "simple stalk section", and eleven of fourteen in which the stalk was divided and a paper plate inserted between its proximal and distal stumps, failed to come into heat when exposed to artificial light during the winter months. In these animals there were "few, if any, vascular connexions between the median eminence and anterior pituitary gland". In those animals which responded to the light, vascular connexions were always present.

The essential argument here is that something failed to happen when certain vessels were few or absent. In its negative quality the evidence is thus similar to other observations which Harris[2] has adduced in support of his views about the function of the pituitary portal vessels. In the present instance, however, Donovan and Harris's experimental findings differ from some we have reported, and they are therefore concerned to find an explanation for the difference. The first point they make is a collateral one, and concerns certain of our findings which show that, while light acting on the retina accelerates œstrus in the normal, but not in the blind ferret, animals blinded in one season tend to come into heat in the years which follow at the same time as do normal controls[4]. Donovan and Harris hold that the experiments from which this conclusion derives are unconvincing, and their contention is that the animals concerned were not blind. They base this view on the fact that no 'anatomical proof' of blindness was given for sixteen animals in which the operative lesions were in the optic chiasma. But they have apparently overlooked the fact that, of the other forty-two animals in the experiment, eight had had their optic nerves, including sheath, and the remaining thirty-four their optic nerves, excluding sheath, divided. Whether the sixteen animals with lesions in the optic chiasma suffered only from form blindness, for which they were tested, there can be no question that the remaining forty-two were blind in the full connotation of the term.

The second point which they make about our work concerns the pituitary portal vessels. They state that our conclusion—that the vessels do not play an essential part in the response—is based only on the fact that two of our stalk-sectioned ferrets which reacted to the light stimulus were found to lack any vascular connexions between the floor of the hypothalamus and the anterior pituitary. This statement is only partly true. Our conclusion is derived from the fact that the response, whether positive or negative, is independent of the presence (or re-establishment) of a direct vascular link after stalk section. Presumably, however, in concentrating on the two particular ferrets to which they refer, Donovan and Harris appreciate what T. E. Huxley[3] put so well in 1863, that "every hypothesis is bound to explain, or, at any rate, not be inconsistent with, the whole of the facts which it professes to account for, . . . One fact with which it is positively inconsistent is worth as much, and as powerful in negativing the hypothesis, as five hundred".

Apart from the question of numbers, Donovan and Harris make three points about these two of our preparations. The first is that our operative approach to the pituitary stalk was not as good as theirs. Whether or not this is true, the point is quite immaterial. What matters is that we have obtained preparations in which the pituitary gland was completely sealed off from direct vascular connexion with the hypothalamus, and in which positive responses to light occurred. Their second point is that it is easier to get a clear picture of the vascular anatomy of the pituitary with sections 100 μ and 200 μ thick than with the thin sections of 10 μ which we have used. And their third, that when they examined the pituitary region of one of the two preparations to which they refer, they found that "a significant proportion of the visible blood vessels did not contain Indian ink". Had Prof. Harris and Mr. Donovan had more time for their examination, they would have seen that these two remarks are incorrect, if by them they mean to imply that 10-μ sections are inadequate to reveal the vascular anatomy of our preparations. Injected vessels are present in every section, and everywhere except where they should be according to the hypothesis that Donovan and Harris are defending. Furthermore, in the preparation in question, a barrier of cellulose (paper) surrounded by reaction tissue completely seals off the median eminence from the anterior lobe, and there is no direct nervous or vascular connexion of any kind between the pituitary on one hand and the base of the brain on the other. This is fully illustrated in the complete account of these experiments[5].

Since the point is of critical importance to the hypothesis which Donovan and Harris are defending, we have made a three-dimensional wax reconstruction of the serial sections of the pituitary region of yet another ferret (reported on for the first time here) which responded to light after the pituitary stalk had been divided and a plate of waxed paper inserted between its proximal and distal stumps. The animal lived for six months after the operation, and the paper became completely surrounded by reaction tissue. The sella turcica containing the pars distalis of the pituitary (the neural process having completely involuted) was roofed over by a massive barrier consisting of a double plate of new bone containing in its interior a mesh of cellulose (Fig. 1). The sections do not reveal any direct vascular connexion between the anterior pituitary and the floor of the brain, but show that the remains of the pituitary portal channels emptied into the vessels of the fibrous reaction tissue on the upper surface of the bone and cellulose barrier. The new bone surrounding

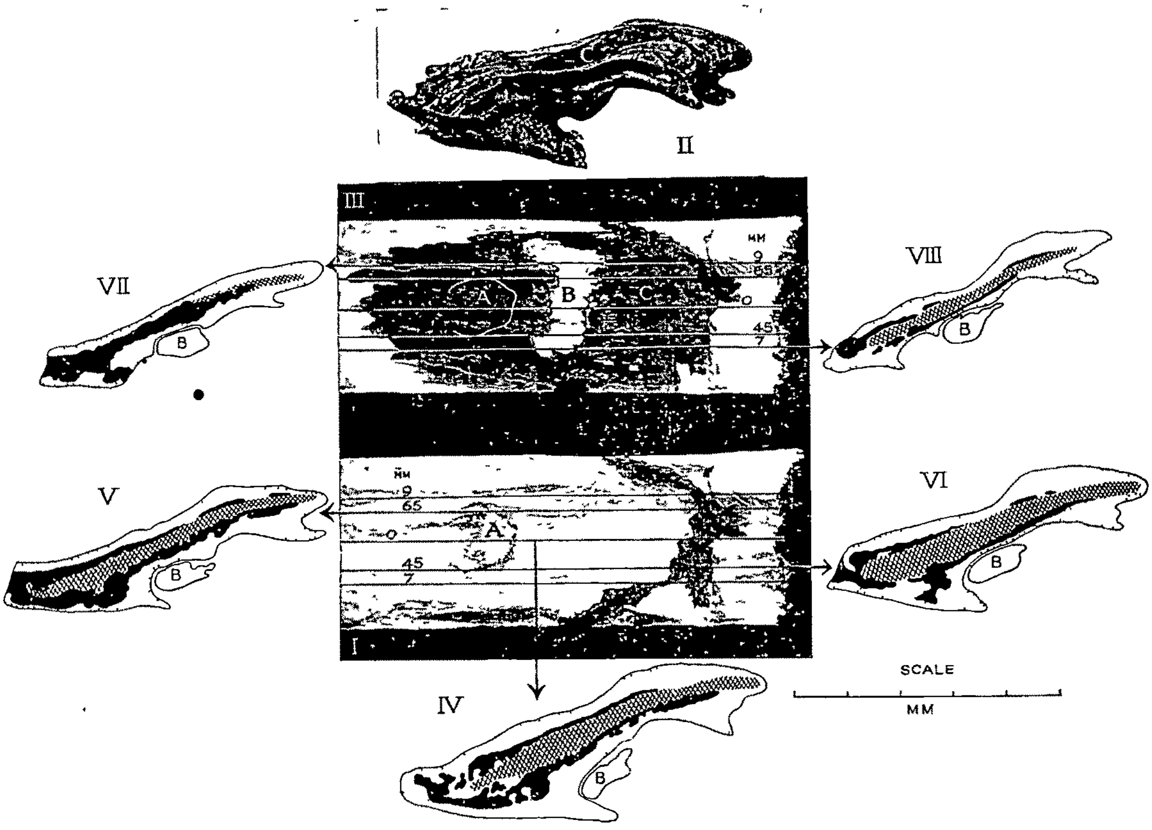


Fig 1 Wax reconstruction of serial sections of pituitary region in a ferret (*T F* 836)

I Floor of hypothalamus, showing median eminence and remains of proximal stump of pituitary stalk (*A*)
II Side view of block of reaction tissue (*C*) which separated the pituitary gland (*B*) from the floor of the hypothalamus It consists of a core of cellulose surrounded by new bone and fibrous tissue
III Block of reaction tissue (*C*) in position between base of brain and pituitary gland (*B*) The position of the median eminence and proximal stump of the pituitary stalk (*A*) has been projected on to the surface and is outlined in white
IV–VIII The five lines intersecting I and III mark the sagittal planes, through the block of reaction tissue, that are illustrated in IV–VIII The position of the anterior pituitary is indicated on each of these figures stippled area, fibrous tissue, solid black, new bone, cross-hatching, broken-up cellulose, *B*, anterior pituitary

the cellulose extended laterally well beyond the margins of the median eminence, and where bone faded out towards the lateral edges of the barrier, the seal separating the pituitary from the lateral part of the floor of the hypothalamus consisted of dense fibrous tissue over which the dura was intact Whether any chemotransmitters, if such exist, that may have passed from the floor of the hypothalamus into the reaction tissue finally reached the anterior pituitary through the systemic circulation does not concern the question under dispute—the proposition that the pituitary portal vessels are essential to the response of the anœstrous ferret to light

The purpose of our experiments has all along been to test Harris's hypothesis by transforming it into the positive question Is a vascular connexion with the median eminence either (*a*) sufficient, other things being equal, or (*b*) necessary for a positive response to light ? And the answer to both questions is no. The proof that a vascular connexion is not sufficient is that in cases where one is present, the response has failed to occur, and more decisive, the proof that it is not necessary is that the response occurs in the complete absence of any direct vascular connexion For these reasons we hold that Harris's hypothesis is untenable The fact that our now extensive investigations reveal many more instances of ferrets failing to respond to light after surgical interference in the region of the pituitary stalk than those now reported by Donovan and Harri does not affect the argument It does, howeve call for explanation We ourselves do not kno why animals that have been subjected to an operation in the region of the pituitary stalk so frequently manifest hypofunction of the pituitary, bu suspect, as do many workers other than Donova and Harris, that it may be due to pathologica changes in the pituitary following on damage to it blood supply, of which the portal vessels constitut a most important element Anyone who has experience of operating in so small an area as that whic surrounds the pituitary gland in an animal the siz of a ferret, and who appreciates how the actua disposition of blood vessels varies from specimen t specimen, will know how difficult it is either to limi or standardize this kind of damage Neverthele our experience shows that it is possible to prepar specimens that provide the necessary conditions fo testing the hypothesis of which the pituitary-porta vessels have been a main prop

Our thanks are due to Mr W J. Pardoe for hi help in preparing the wax reconstruction

[1] Donovan, B T, and Harris, G W, *Nature*, **174**, 503 (1954)
[2] Harris, G W, Ciba Found Coll Endocrin, 4, 106 (1952)
[3] Huxley, T H, in "Darwiniana", Essay No XI (Macmillan, Londo 1894)
[4] Thomson A P D, *Proc Roy Soc*, B, **142**, 126 (1954)
[5] Thomson, A P D, and Zuckerman, S, *Proc Roy Soc*, B, **142**, 43 (1954)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Observation of Desert Locust Swarms by Radar

THE possibility of detecting flying locusts by radar was examined theoretically some years ago, using the deduction of Ryde[1] that the intensity of a centimetric radar echo from raindrops is proportional to ΣND^6, where N is the number of drops of diameter D per unit volume Raindrops do not exceed about 6 mm in diameter , and recorded rainfall intensities indicate that there can rarely be more than ten such drops per cubic metre in the heaviest precipitation. More than half the weight of a locust is water , from considerations of water-content alone, a swarm averaging ten flying locusts per cubic metre, as recorded in the Kenya Highlands in 1945 [2], with each locust containing about 1 c c of water, might be expected to give an echo of intensity at least an order of magnitude greater than that given by the very heavy precipitation considered , and it was concluded that recognizable echoes might well be given by much more attenuated swarms Subsequent field-work[3,4] has suggested that considerably lower volume densities, of the order of 0 1 locust per cubic metre, are in fact more representative of even the denser parts of flying swarms , densities of this order, however, might still be expected to give echoes comparable with those given by heavy precipitation

Radar equipment was known to be in regular use in the determination of upper winds at a series of meteorological stations within the invasion area of the desert locust (*Schistocerca gregaria* Forsk), and an approach was accordingly made in 1950 to the Meteorological Office, through the Anti-Locust Research Centre. The co-operation of the Air Ministry stations concerned was at once offered by the Meteorological Office, with the comment that, since the back-scattering of the radiated energy is largely a surface phenomenon, results were likely to be somewhat better than would be indicated by considerations of water-content alone At the same time it was pointed out that a type of radar giving plan-position-indicator form of presentation would be more suitable for observing locusts than the *GL* III equipment in use at the meteorological stations concerned.

The first radar sighting of a locust swarm was in fact recorded at 17 00 G M T (20 15 local time) on March 22, 1954, at lat 28° 50′ N , long 49° 30′ E , in the Persian Gulf about midway between Bushire and Kuwait, by H.M S *Wild Goose* A naval centimetric combined air- and surface-warning radar set was used, with a tilted parabolic cheese aerial. The locusts appeared to constitute a swarm of at least 15 miles radius, and were detected at ranges up to sixty miles, over a sector of up to 80°, giving large 'fluffy' echoes on a plan-position-indicator, similar to the effects of mechanical jamming Flying locusts were seen at the time in the light of a 10-in signalling projector, and dead ones were seen next morning floating on the sea, at a density estimated at about a thousand locusts over 40,000 sq. yd This confirmation of the earlier theoretical conclusion opens up possibilities of securing new information on the structure, density and movement of flying swarms which come within range of suitable radar installations, especially from photographic records of the echoes observed , such data are likely to be of particular value in the further development of aircraft methods of attacking flying swarms[3]

The locusts concerned were mature (yellow) desert locusts, and were recorded as moving very slowly southwards The wind was light and variable at the time, following a spell of moderate north-westerlies over the northern Persian Gulf during March 21 and the morning of March 22 (data provided by Chief Meteorological Officer, Middle East Air Force) The locusts represented in all probability one of a number of mature swarms which had been present since late February in the Kuwait area, about a hundred miles to the west and north-west of the position of the ship report

The time of the radar sighting was two hours after sunset and three-quarters of an hour before moonrise , and the report is of considerable interest as evidence of flight in swarm formation in darkness and over the sea, when visual reactions might be expected to have been minimal and auditory reactions[5] may well have been involved in maintaining swarm cohesion The air temperature recorded at the time at the ship was 69° F , which is several degrees lower than has previously been recorded during the night flight of desert locusts on such a scale[6] Most of the locusts, flying higher than the level of the ship, are, however, likely to have been experiencing temperatures above 69° , radiosonde observations from Bahrein Island recorded temperatures of 80° at 1,600 ft at 14 30 G M T the same day and 78° at 950 ft at 02 05 the following morning, respectively 7 deg and 11 deg above the corresponding surface temperatures[7]. The establishment of such a temperature inversion over the Persian Gulf is usual during March[8]

The co-operation of the Royal Navy, the Meteorological Office, and the East African Meteorological Department is gratefully acknowledged.

R C RAINEY

Desert Locust Survey Headquarters,
Nairobi, Kenya.
Nov. 24.

[1] Ryde, J W (1946), in Jones, R F , *Quart J Roy Met Soc*, **76**, 312 (1950)

[2] Gunn, D L , Perry, F C , *et al* , Anti-Locust Bull , No 3 (1948)

[3] Rainey, R C , and Sayer, H J , *Nature*, **172**, 224 (1953)

[4] Waloff, Z , *et al* , unpublished field data (1951–54)

[5] Pumphrey, R J , in Kennedy, J S , *Phil Trans Roy Soc* , B, **235**, 226 (1951)

[6] Rainey, R C , and Ashall, C , *Brit J Anim Behav* , **1**, 136 (1953)

[7] Overseas Supplement to the Daily Weather Report of the Meteorological Office, London, Nos 1177–1178

[8] Durst, C S , Meteorological factors in radio wave propagation, Phys Soc and Roy Met Soc , p 193 (1946)

Widespread Diurnal Variations of Effective Slope of the Ionosphere

OVER a period of twelve months, measurements have been made at Seagrove Radio Research Station of the bearing and elevation angles of radio signals received from two transmitting stations at about the same distance but in directions differing by almost 90° from the receiving station From these measurements the effective slopes of the ionosphere have been found to be related at places about 1,500 km apart, and the average diurnal variation of these slopes has been measured.

The measurements were made on the rotating interferometer situated at Seagrove, Auckland[1], and refer to the horizontally polarized component of the incoming wave The equipment is such that the observed incoming angle is that of the particular wave which gives the greatest output from the horizontal multiple-loop aerials employed

The two transmitting stations chosen for this investigation were *ZQD*, Nandi, Fiji, on 9,315 kc /s, distant 2,000 km almost magnetically north, and *VLQ*9, Brisbane, Queensland, on 9,660 kc /s, distant 2,250 km almost magnetically west

The measured angles were averaged over each hourly period and then over as many days as possible in each month.

Let $\delta(x)$ be the measured elevation angle for station x, $\Delta(x)$ the elevation angle for station x which would have been measured in the presence of a horizontal ionosphere, $\theta(x)$ the measured bearing angle for station x, $\Theta(x)$ the great circle bearing, measured east of north, $\psi(NS)$, $\psi(EW)$ the effective slopes of the ionosphere about north–south and east–west lines as axes the slope angle being measured from the horizontal and regarded as positive for an increasing height towards the north or east

Then, if the angles of arrival may be assumed to occur as the sum of the various ionospheric effects, we have

$$\begin{aligned} \delta(ZQD) &= \Delta(ZQD) + \psi(EW) \\ \delta(VLQ9) &= \Delta(VLQ9) - \psi(NS) \\ \theta(ZQD) &= \Theta(ZQD) - k\,\psi(NS) \\ \theta(VLQ9) &= \Theta(VLQ9) - k\,\psi(EW), \end{aligned} \tag{1}$$

where k is a factor depending on the geometry of the transmission paths

From the measured angles it has been possible to choose some months during which conditions over the two paths were similar enough for $\Delta(ZQD)$ and $\Delta(VLQ9)$ to be considered identical (except for a small constant factor arising from the small difference in path-length) Under these conditions, it can be seen from equations (1) that a plot of $\{\delta(ZQD) - \delta(VLQ9)\}$ as a function of $\{\theta(ZQD) + \theta(VLQ9)\}$ defines straight line of slope $-1/k$ In Fig 1 the exp mental results averaged over the months July (19 and March, April and May (1954) have been plot in this way The times shown against the poi refer to local time at the mid-point of the path points lie on a line of slope $-0\ 5$ during the d time, but the points for night-time indicate that assumption of equality of $\Delta(ZQD)$ and $\Delta(VLQ9)$ not then valid

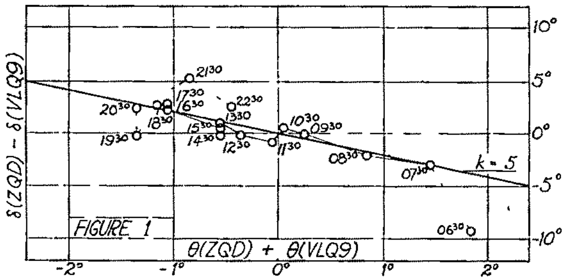


FIGURE 1

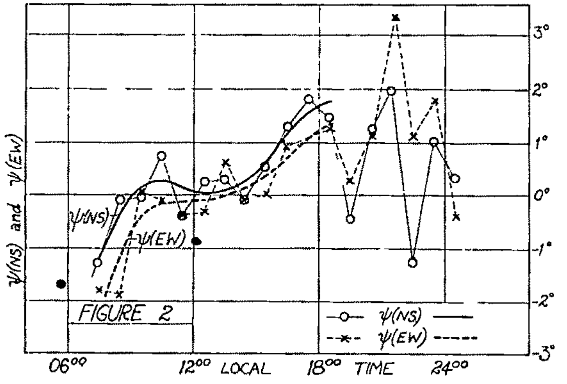


FIGURE 2

Using the experimental value of $k = 0\ 5$, effective slopes of the ionosphere may be fou since (apart from some constant factors),

$$\begin{aligned} 2\psi(NS) &= \delta(ZQD) - \delta(VLQ9) - \{\theta(ZQD) - \theta(VLQ9)\} \\ 2\psi(EW) &= \delta(ZQD) - \delta(VLQ9) + \{\theta(ZQD) - \theta(VLQ9)\} \end{aligned}$$

$\psi(NS)$ and $\psi(EW)$ have been plotted in Fig from equations 2 using the same experimental resu as before The heavy full and dotted lines show smoothed day-time behaviour

The Seagrove Radio Research Station is opera by the Physics Department, Auckland Univers College, and receives a grant from the New Zeala Department of Scientific and Industrial Resear The work briefly described above is to be publish more fully elsewhere

H A WHALE

Seagrove Radio Research Station,
Auckland, N Z
Aug 19

[1] Whale, H A, *Proc Phys Soc*, [B, 67, 553 (1954)]

Radio Astronomy in Hawaii

SINCE early 1953, observations of cosmic sta have been made at an altitude of 10,020 ft. from t top of Haleakala volcano on the island of Maui the Hawaiian archipelago near lat. 20° N. A Lloy mirror technique is used with frequencies near 30, 50 and 100 Mc /s The anomalies introduced the ionosphere at the first three frequencies are great that most of the results are unintelligib At 100 Mc /s the situation is sufficiently simple be partly understood Sources with discontinuit of surface brightness small compared to a minute arc produce rapid interference patterns Smo sources of larger angular width produce much slow diffraction patterns The hours of darkness prov the best results During the day, radiations from t sun stir up the topmost parts of the atmosphere above the *F*-layer. This situation manifests its as great absorption, probably due to scatteri especially during the afternoon hours Thus there a marked diurnal effect. This diurnal effect is le on far northern sources and increases rapidly magnitude and duration as sources of lower decl tion are observed Obviously, there is also an azimu effect

During the present part of the solar activity cy the background intensity of the sun is very consta from day to day and month to month Also t azimuth of the sun changes with the seasons. Wh farthest north at the summer solstice, quite acce able and reproducible diffraction patterns a secured If a very small bright source is also prese a faint interference pattern may be riding alo on top. With the advance of the seasons, the s moves south and the results depreciate. The fa interference patterns disappear, the diffraction p rn gets weak, sunrise appears late and is not distinct y the time the autumnal equinox arrives the solar attern is merely incoherent fluctuations having a eriod of 3–20 min with an amplitude less than a nth that present near the summer solstice As us is being written, the sun has faded out altogether ear the horizon and can only be detected through e high secondary lobes of the antenna The best cplanation of these observations seems to be that iere is a great bulge in the outer parts of the earth's mosphere approximating to a thick disk perhaps)° or 40° wide When looking out to the north, one oserves through a thin and relatively transparent gion As the source moves farther south, the line sight has to traverse a longer path through the urbulent scattering region, and less energy arrives a more incoherent state at the observer The situaon at sunset is similar to that described above, ccept that the phenomena are more complex due the presence of well-developed E- and F_1-layers hich are usually absent at sunrise It seems profitble to follow up these observations at other freuencies

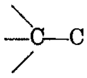
The outstanding sources in Cassiopeia and Cygnus ill show interference patterns at 100 Mc /s Both oparently are of considerable asymmetry because e rising and setting patterns are different This uation is particularly marked in the case of issiopeia, which produces an excellent compound terference pattern on rising but only a diffraction ttern on setting The details of these studies will described elsewhere They are supported by the esearch Corporation

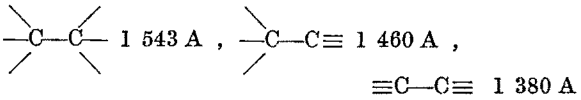
GROTE REBER

Wailuku, Maui,
Hawaii
Oct. 12.

Carbon–Carbon and Carbon–Hydrogen Distances in Simple Polyatomic Molecules

A DEPENDENCE of bond distances on environment is first noticed when the carbon–carbon single-bond stance in methyl acetylene was compared with at in ethane[1]. In recent years, a wealth of material sed mainly on infra-red and microwave spectra[2] s confirmed this dependence Still more recently, e study of high-resolution rotational Raman ectra has supplied further data (partly unpublished) this dependence It is the purpose of this comunication to review briefly the results of the work carbon–carbon and carbon–hydrogen distances

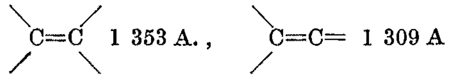
A number of compounds have now been investigated which, similar to methyl acetylene, a carbon–carbon igle bond is adjacent to a triple bond In all these ses, the C—C distance comes out to be close to at originally found for methyl acetylene, namely, 460 ± 0 003 A, whereas in ethane and in diamond, iere all adjacent bonds are single, the C—C distances 1 543 A [3] and 1 54447 A [4], respectively The result the  distance appears to be largely dependent of whether the atom attached to the ple bond is carbon or nitrogen It was first shown Pauling, Springall and Palmer[5] by means of ectron diffraction that the C—C distances in diacetylene and dicyanogen, with a triple bond on each side of the C—C bond, are even smaller than in methyl acetylene and similar compounds More precise values have more recently been obtained by Vallance Jones[6], Westenberg and Wilson[7] and Møller and Stoicheff[8] The average, again independent of whether carbon or nitrogen is attached to the triple bond, is 1 380 ± 0 002 A Thus we have the series



1 543 A , 1 460 A , ≡C—C≡ 1 380 A

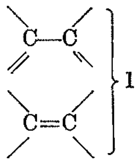
The decrease from the second to the third distance is approximately the same as from the first to the second

The carbon–carbon double-bond distance in ethylene is well known to be 1 353 A, as shown by Gallaway and Barker[9] One of us (B P S, unpublished) has recently obtained the rotational Raman spectra of light and heavy allene (C_3H_4 and C_3D_4), in which there are two adjacent C=C bonds The spectra give for the carbon–carbon distance 1 309 A, a value that is appreciably lower than that of a C=C bond surrounded by single bonds only A similar though less accurate value has been obtained by Johnson and Strandberg[10] for ketene (CH_2CO) Thus we have



1 353 A., 1 309 A

Recently, from the rotational Raman spectrum, Stoicheff[11] has obtained a precise value of the carbon–carbon distance in benzene, namely, 1 397 A This value corresponds to a mixture of a single bond adjacent to two double bonds and a double bond adjacent to single bonds Unfortunately, the former is not yet known separately However, we may write



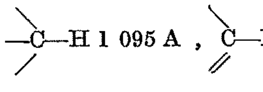
1 397 A

For comparison, the carbon–carbon triple bond distance is

—C≡C— 1 207 A,

a value that is surprisingly independent of the type of atom attached to the single bonds In particular, in methyl acetylene[12], cyanoacetylene[7], and dimethyl triacetylene[13] (X-ray diffraction), the triple bond maintains its normal length in spite of the fact that the adjacent C—C single bond has apparently borrowed some strength from the triple bonds, that is, is considerably reduced in length One might have expected that the triple bond in these compounds would be longer than normal

The carbon–hydrogen distance also depends on the environment, as has been pointed out before[14], but the dependence is not as strong as for the carbon–carbon distances. Using recent data, we have



—C—H 1 095 A , C—H 1 07₁ A., ≡C—H 1 065 A.

Of these values, that for ≡C—H is an equilibrium internuclear distance, whereas all other values quoted here are r_0 values, that is, they include zero-point vibration The value for $\equiv$C—H is probably the most accurate, that for $\overset{\diagdown}{\underset{/\!/}{\mathrm{C}}}$H the least accurate. For benzene, which might have been expected to give a value similar to ethylene, Stoicheff[11] found 1 084 A. Slightly different values for the C—H distance in methane are obtained, depending on which isotope is chosen, but they are within a few thousandths of the value given

Similar differences have been found by several authors[15] for the C—Cl, C—Br, C—I bonds, depending on whether they are adjacent to a triple bond or single bonds. But in these cases, unlike those discussed above, there is also a dependence on the adjacent atoms. A clear case of this kind is the $\overset{\diagdown}{\underset{/}{—\mathrm{C}}}$—F bond which, in methyl fluoride[16], has the length 1 385, in fluoroform 1 332 A [17]. However, in the case of the C—C, C=C, C$\equiv$C and C—H bonds, the effect of adjacent atoms on the bond-length seems to be small compared to the effect of the adjacent bond-type

G HERZBERG
B. P. STOICHEFF

Division of Physics,
National Research Council of Canada,
Ottawa.
Sept 27

[1] Herzberg, G, Patat, F, and Verleger, H, *J Phys Chem*, **41**, 123 (1937)

[2] See, for example, Herzberg, G, *Nature*, **169**, 997 (1952)

[3] Hansen, G E, and Dennison, D M, *J Chem Phys*, **20**, 313 (1952)

[4] Lonsdale, K, *Phil Trans Roy Soc*, A, **240**, 219 (1947)

[5] Pauling, L, Springall, H D, and Palmer, K J, *J Amer Chem Soc*, **61**, 927 (1939)

[6] Jones, A Vallance, *J Chem Phys*, **20**, 860 (1952)

[7] Westenberg, A A, and Wilson, jun, E B, *J Amer Chem Soc*, **72**, 199 (1950)

[8] Møller, C K, and Stoicheff, B P, *Can J Phys*, [**32**, 635 (1954)]

[9] Gallaway, W S, and Barker, E F, *J Chem Phys*, **10**, 88 (1942)

[10] Johnson, H R, and Strandberg, M W P, *J Chem Phys*, **20**, 687 (1952)

[11] Stoicheff, B P, *Can J Phys*, **32**, 339 (1954)

[12] Trambarulo, R, and Gordy, W, *J Chem Phys*, **18**, 1613 (1950)

[13] Jeffrey, G A, and Rollett, J S, *Proc Roy Soc*, A, **213** 86 (1952)

[14] Herzberg, G, "Molecular Spectra and Molecular Structure", 2, "Infrared and Raman Spectra of Polyatomic Molecules", 440 (D Van Nostrand Co, Inc, New York, 1945)

[15] See Gordy, W, Smith, W V, and Trambarulo, R F, "Microwave Spectroscopy" (John Wiley and Sons, Inc, New York, 1953)

[16] Gilliam, O R, Edwards, H D, and Gordy, W, *Phys Rev*, **75**, 1014 (1949)

[17] Bernstein, H J, and Herzberg, G, *J Chem Phys*, **16**, 30 (1948) Ghosh, S N, Trambarulo, R, and Gordy, W, *J Chem Phys*, **20**, 605 (1952)

Corrosion Fatigue of Low-Alloy Chromium–Molybdenum Steel as affected by the State of Heat Treatment

MANUEL has shown[1] that the spheroidized zones which exist on each side of a weld in plain carbon steel are a source of accelerated corrosion in oil-well drilling tubes

Modern hollow mining-drill steel rods possess such a spheroidized zone near the shank end. The rods are manufactured from as-rolled material, the shank end being austenitized, quenched and tempered. Thus there exists in the rod a short section containing spheroidized carbide, which occurs at the junction of the as-rolled body and the heat-treated shank. This zone can be distinguished by a marked 'valley' in a hardness traverse carried out along the rod, l etching and by micro-examination

Approximately 95 per cent of mining-drill ste rods in use at Kalgoorlie have the following cor position carbon 0 97 per cent, chromium 1 15 p cent, molybdenum 0 25 per cent, silicon 0 20 p cent, manganese 0 25 per cent

In a group of fifty fractures of such rods whi has been examined here, it was observed that fracture occurred at the point of lowest hardne (the fully spheroidized section) where fatigue failu would be expected to occur The fatigue limit of t steel with fully spheroidized carbide was estimat from tensile test results to be 66,500 lb. per sq However, in the case of thirty-seven of the fractur failure occurred at the point where spheroidizat was just beginning, the stepped surface of the failures pointing to corrosion fatigue The fatig limit of this structure was estimated from tens test results to be 107,300 lb. per sq in. The sour of failure in each case was at the central hole

A ferroxyl accelerated corrosion test was carr out on a scale-free shank containing a spheroidiz zone, illustrated in Fig 1 (above) It was observ that marked accelerated corrosion occurred at t spheroidized zone, as shown in Fig 1 (below) Th zone was thus more anodic than any other poi on the surface, the internal hole acting as cathode this test

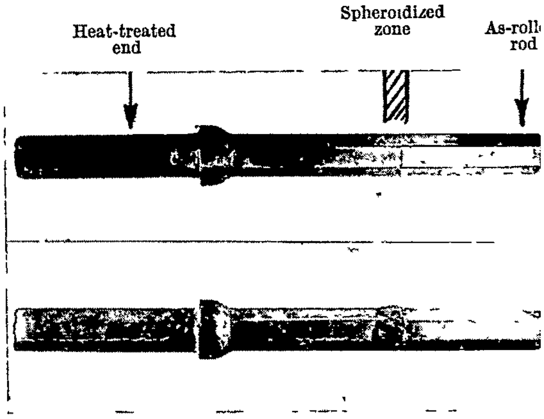


Fig 1 *Above* Shank end of drill steel, showing the junctio between as-rolled rod and the heat-treated end, at which th spheroidized zone occurs

Below Same shank as above, after immersion for seven day in ferroxyl reagent The adhering band is of agar jell containing the complex ferrous-ferricyanide ion This ban marks the highly anodic region which corresponds to th spheroidized zone above

In practice, accelerated corrosion occurs at spheroidized zone from the internal hole, the flush water in this hole acting as electrolyte The corros pits produced then act as stress concentrators, a failure occurs by corrosion fatigue.

Further work is proposed to investigate the eff of heat treatment on the rate of corrosion of ste covering a range of compositions, the tests includ loss of weight and electrode potential measureme of samples with various structures

D. S. KEMSLEY

School of Mines of W.A,
Kalgoorlie,
Western Australia.
July 30

[1] Manuel, R W, *Corrosion*, **3**, 415 (1947)

A Light Condenser for Spectrographical Purposes

THE luminosity of a transparent light source, such s a fluorescent liquid, can be intensified by the rinciple of superposition[1] We have devised an ntensifying device for spectrographical purposes pplicable directly to a light-emitting tube

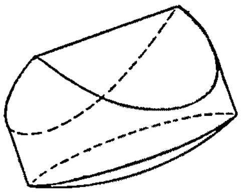


Fig 1

Two special prisms P_1, P_2, each of which is a ombination of a right-angled prism and a convex ens, having an axis of symmetry (Fig 1), are set t a distance apart from each other, the lens surfaces ace to face, with the axes on the same line, and the wo edges parallel to each other (Fig 2) Let the radii f curvature R_1, R_2 of the lens surfaces L_1, L_2, the istance between them l, and the distances d_1, d_2 etween the edges and the lens surfaces in the espective prisms, be limited by the following conditions for convenience sake (1) $R_1 = R_2$, (2) $d_1 =$ ${}_2$, (3) the foci on both sides of the lens systems ${}_1$, L_2 fall on the two edges E_1, E_2 of the prisms espectively

It is most important to make the angle of ${}_1$ exactly 90°, and the angle of P_2 $90° - \varepsilon$, where is a very small angle

Though in practice excitation of light is taking lace in the space between L_1 and L_2, to make the xplanation easier we assume for the moment a light ource on the plane S, which contains E_1 and is erpendicular to the common axis, and is imagined o be in the prism substance It will be shown later hat the imaginary source has an effect equivalent o the actual one in this case From the light pencil mitted from a point Q on S in the direction of P_2, e take the ray $Q(1)$, which is parallel to the axis, 1) being the point at which the ray falls on the lens urface L_1

Though the ray $Q(1)$ passes on and goes through ${}_2$, a ray which comes infinitesimally close to $Q(1)$ nd on the nearer side to the axis falls first on the otal reflecting plane T_2' and then on T_2, and when t comes back again to the surface L_1, it strikes the oint (2) which is nearer to the axis by $2\varepsilon d_2 + 2\varepsilon ln$ han (1), where n is the refractive index at L_2 As n the prism P_1 the ray advances parallel to the xis, it falls on S at the point Q', which is also nearer to E_1 by $2\varepsilon d_2 + 2\varepsilon ln$ than Q Of the light pencil emitted from Q as imagined above, that half which is on the nearer side of $Q(1)$ to the axis (let us call this an inside half-pencil) becomes a parallel beam in P_2, and suffering total reflexion twice, by T_2' and T_2 successively, it returns to P_1 and converges to Q' on S Thus the image of Q made by the inside half-pencil is Q', which is $2\varepsilon d_2 + 2\varepsilon ln$ nearer to the edge than Q But actually, before it converges to Q' the pencil returns once more to P_2 by total reflexions at T_1 and T_1', just as it starts from the point Q'', which is symmetrical to Q' with reference to the neutral plane It will be noticed that the restarting pencil is inside, the converging one to Q' being outside Now the position is the same as the starting point, and the next image of Q'' is formed on S and $2\varepsilon d_2 + 2\varepsilon ln$ nearer E_1 than Q''

If we make a narrow plane S_1 perpendicular to the axis, by removing the edge E_1, it is clear that the circulating half-pencil comes at last to intersect this plane S_1, and is superposed here on the direct beam If in practice excitation of light is taking place in the space between L_1 and L_2, the effective imaginary pencil starting from Q passes perfectly through the emitting space, and we can thus substitute a real pencil for the assumed one within the meaning of geometrical optics On the other hand, successive images of Q made by the outside half-pencil arrive on S farther and farther from the axis, and we can never collect them

Next, we calculate the total luminosity I_t given by inside half-pencils at S_1 If we denote the luminosity of the direct beam coming through the window L_1 and S_1 by I, and the rate of intensity loss during one circulation by r, I_t is given by

$$I_t = 2\{I + (l - r)\, I + (l - r)^2\, I + \quad .\}$$

in which the term number is given in the most favourable case ($2\,\varepsilon d_2 + 2\varepsilon ln = b$) by $\frac{A}{2}\Big/b$, where A is the aperture of L_1 and b the breadth of S_1 The factor $\frac{A}{2}$ arises from the fact that a pair of symmetrical points on S gives a perfect beam through S_1, and that the actual rays emitted between L_1 and L_2 give, on one hand, a pencil diverging from Q, and on the other, converging to the point

If we neglect absorption loss, we are only concerned with the reflexion losses at L_1 and L_2 Let us assume $r = 16$ per cent, considering a case of emission from a gas, then

$$I_t = 2I\ \{1 + \frac{84}{100} + \left(\frac{84}{100}\right)^2 + \left(\frac{84}{100}\right)^3 + \quad \}$$

If we make b sufficiently small compared to A, we can take as an approximation the infinite series, and

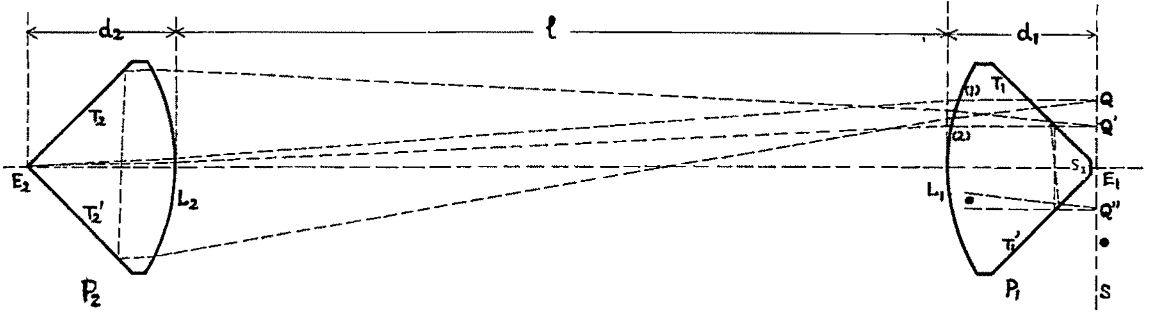


Fig 2

$$I_t = 2I \frac{1}{1 - \frac{84}{100}} = 2 \times \frac{100}{16} I = 12I.$$

But when the emitting substance is a liquid, we can generally expect a larger intensification owing to a smaller r Generally speaking, a high refractive index of the prism substance is required at T_1, T_1', T_2 and T_2' to make the reflexions perfect, whereas at L_1 and L_2 a low value is preferable to make r small It is very difficult to make the prism angles exactly correct With our discharge tube, on the ends of which the two special prisms are stuck, ε is somewhat smaller than the value calculated, and the value of I_t was only $7I$

KENZO TOISHI

Institute of Research for Cultural Properties,
Ueno Park, Tokyo.

SENZO MIURA

Nihon University,
Ekoda, Nerima-ku, Tokyo
May 26

[1] Toishi, K , *Sci Pap I P C R*, 40, 151 (1942) White, J U , *J Opt Soc Amer*, 40, 803 (1950) Welsh, H L , Cumming, C , and Stansbury, E J , *J Opt Soc Amer*, 41, 712 (1951) Toishi, K *J Sci Res Inst*, 46, 8 (1952)

Uniform Field Breakdown in Air

RECENT work by Llewellyn Jones and Parker[1] on the steady-state current flow in a uniform field gap in air subjected to a steady d c potential has been interpreted in terms of the Townsend theory of breakdown involving a secondary or γ-process Oscillographic observation, however, shows that, as the breakdown voltage is approached, relatively high current pulses of short duration occur. It can be shown that these pulses, both in amplitude and frequency of repetition, do not conform to the Townsend theory, and this suggests that another mechanism is involved

It can also be shown that, when a high value of series resistor is included in the circuit, it is in theory virtually impossible to reach the Townsend criterion for breakdown Experimentally, however, no difficulty is experienced in causing a breakdown under these conditions.

The application of stochastic methods to the Townsend theory of breakdown shows that, even if the secondary process is assumed to be the fastest possible, that is, entirely photoelectric in nature, the calculated formative time-lags are longer than those observed experimentally[2] and that the discharge would be diffuse Experimentally, the discharge is observed to be filamentary

Further, the velocity of observable luminosity across the gap, on the Townsend theory, is slower than the experimentally observed velocity by a factor of about 10^4

The above evidence suggests that in addition to the Townsend mechanism, a streamer-like mechanism is also involved in the breakdown of the uniform field gap in air for values of $pd \sim 500$ mm. Hg cm. The best agreement with the available experimental evidence appears to be obtained by postulating that the current build-up due to the Townsend primary and secondary processes provides conditions favourable for the initiation of the streamer. The streamer then moves across the gap and causes the breakdown to be completed Such a postulate also provides a single theory to explain the breakdo of gaps of different geometry, the geometry decid the manner in which the critical conditions f streamer initiation are established.

On the above mechanism, it can be shown th the existence of a secondary process is not essent to cause breakdown, and that the failure of so experimenters to detect a secondary process is therel explained.

A full discussion is being prepared for submissi elsewhere. This work was done during my ten of an I.C I. research fellowship, which is grateful acknowledged

R F. SAXE

Department of Electrical Engineering,
Queen Mary College,
University of London,
London, E.1.
Sept 29

[1] Llewellyn Jones, F , and Parker, A B , *Proc Roy Soc*, A, 213, (1952)

[2] Fisher L H , and Bederson, B , *Phys Rev*, 81, 109 (1951)

Preparation of Solid Solutions of Free Radicals at Room Temperature

ORGANIC free radicals can be produced by irradi tion with ultra-violet light of molecules held in transparent rigid medium at low temperatures[1,2]. T method consists in dissolving a suitable substance, in a solvent which forms a transparent glass freezing. The solution is cooled to the temperatu of liquid nitrogen and exposed to ultra-violet ligl After a time it becomes coloured, and optical absor tion spectroscopy shows that free radicals have be created. These radicals persist until the glass warmed so as to lose its rigidity Such radicals m be formed in several ways, but the simplest of the is 'photo-oxidation'[1]—the ejection of an electron fro the illuminated molecule, D. We restrict ourselv to those substances which form radicals only by tl process. It seems that the high viscosity of t glassy solvent prevents the recombination of t resulting radical ion, D^+, and the ejected electro

The use of solutions at the temperature of liqu nitrogen is not always convenient, so we ha investigated the possibility of producing free radic at room temperature Instead of using a solve which freezes to a glass, we tried to create fr radicals in a medium which is glass-like at roo temperatures and which, moreover, can be form without heating A solid solution in transpare methyl methacrylate plastic (I C I 'Perspex') w used, and this was illuminated at room temperatu Such a solution was prepared as follows so N,N'-tetramethyl *p*-phenylenediamine ('Wurste base', $(CH_3)_2N\,C_6H_4\,N(CH_3)_2$), which is known form free radical ions by photo-oxidation, w dissolved in chloroform, and mixed with a liqu solution of 'Perspex', also in chloroform. The flu was then poured on to a glass plate and the chlo form evaporated, leaving a thin film behind. Aft illumination at room temperature for 5 min. wi ultra-violet light from a high-pressure mercury lam the film turned brown It was shown by means paramagnetic resonance[3] that free radicals were n present in the film A sample was made by fold the film into a pellet, and a single paramagne resonance absorption line was found, a few gauss width and with $g = 2\ 001 \pm 0\ 002$, which is typi of a free radical. The dependence of the resonance absorption on temperature was similar to that of Wurster's radical ion, $(CH_3)_2N\,(C_6H_4)\,N(CH_3)_2^+$, the intensity of the absorption rising to a maximum near 200° K [4].

Films of pure 'Perspex' showed no paramagnetic resonance after illumination with ultra-violet light

The experiment was repeated with a solution of *p*-phenylenediamine, $NH_2\,C_6H_4\,NH_2$, which also forms free radical ions by photo-oxidation, though less easily than Wurster's base After 25 min illumination, the film became coloured, brown at the edges and grey-green in the centre Paramagnetic resonance showed that free radicals were present in the film, the concentration being greater in the grey-green part

The radicals produced in this manner are rather stable. Paramagnetic resonance of about the original intensity was found after the illuminated film had been kept for a month at room temperature After ten months, however, paramagnetic resonance could not be detected, although the film remained coloured It is noteworthy that, though these substances deteriorate in air, a sufficient number of molecules survive the film-making process to give a reasonable yield of free radicals.

The use of a thin film allows the formation of free radicals throughout the sample, even by quanta corresponding to wave-lengths where the absorption of the 'Perspex' becomes appreciable (less than about 3,000 A) These radiations will, however, be able to pass through such a thin film Furthermore, a thin transparent film should be convenient for optical measurements, and this technique should be useful for studying free radicals which are normally unstable

We are indebted to the University of Oxford for the award of a Pressed Steel Co , Ltd , research fellowship (D. B), and to the Department of Scientific and Industrial Research for a maintenance grant (A. C R.-I) during the tenure of which these researches were carried out

D BIJL
A C ROSE-INNES

Clarendon Laboratory,
Oxford.
Nov. 6.

Lewis G N , *et al* , *J Amer Chem Soc* , 64, 2801 (1942) , 65, 520, 2419, 2424 (1943)

Norman, I , and Porter G , *Nature*, 174, 508 (1954)

Bleaney, B and Stevens, K W H , Reports on Progress in Physics, 16, 109 (1935)

Chu, T L , Pake, G E , Paul, D E Townsend, J , and Weissman, S I *J Phys Chem* , 57, 504 (1953)

Solubility of Oxygen in Water

In a recent communication, Truesdale and Downing[1] reported that the values for the solubility of oxygen in de-ionized distilled water, determined by the Winkler[2] method, were significantly lower than the standard values commonly employed[3] They gave a new empirical equation valid in the range 0–40° C , relating the solubility and the temperature

In connexion with some investigations on the salting-out of oxygen in aqueous electrolytes a number of determinations of the solubility of oxygen in distilled water at 25° C were made over a period of several months The Winkler method, modified to the extent that 0 01 *N* thiosulphate instead of 0 025 *N* usually recommended was employed and, as in the case of the authors mentioned, air freed from carbon dioxide and saturated with water vapour was used In the experimental arrangement the air was drawn slowly through the water until equilibrium was established

The results obtained at 25° C. in five series of determinations gave values, corrected for pressure, in the range 8 07 ± 0 05 p p m. The equation of Truesdale and Downing yields at 25° C a value of 8 11 p p m , while the figure quoted in "Standard Methods"[3] is 8 38 p p m. The present results are an independent confirmation of the results recently reported and underline the need for a revision of the 'standard' values

J A ALLEN

Department of Chemistry,
University of Tasmania,
Hobart, Tasmania
Sept 2

---

[1] Truesdale, G A , and Downing, A L , *Nature*, 173, 1236 (1954)

[2] Winkler, L W , *Ber dtsch chem Ges* 21, 2843 (1888)

[3] American Public Health Association, "Standard Methods for the Examination of Water and Sewage" 9th edit (New York, 1946)

Oxygen Exchange between Nitrous Acid and Water

THE exchange of oxygen atoms between nitrous acid and isotopically enriched water has been followed by the isolation of the nitrous acid as its insoluble silver salt, and the decomposition of this salt, to water, by heating with dry ammonium chloride *in vacuo*. The water produced was then equilibrated with carbon dioxide, and the isotopic content of this gas determined mass spectrometrically

The work of Hughes, Ingold and Ridd, and Schmid (summarized in ref 1), showed that under appropriate conditions the active nitrosating agent in diazotization was dinitrogen trioxide, N_2O_3, formed by the reaction

$$H_2N^+O_2 + NO^-_2 \rightleftharpoons N_2O_3 + H_2O , \qquad (1)$$

but that under somewhat different conditions the reagent was either the nitrous acidium ion, $H_2N^+O_2$, or the nitrosonium ion, N^+O, derived from it.

Any of these entities, or all, could give oxygen exchange between nitrous acid and water, by reaction (1), by the hydration of the nitrosonium ion (2), or by the reaction between water and the nitrous acidium ion (3)

$$N^+O + H_2O \rightleftharpoons H_2N^+O_2 \qquad (2)$$

$$H_2{}^{18}O + H_2N^+O_2 \rightleftharpoons H_2N^+O^{18}O + H_2O \qquad (3)$$

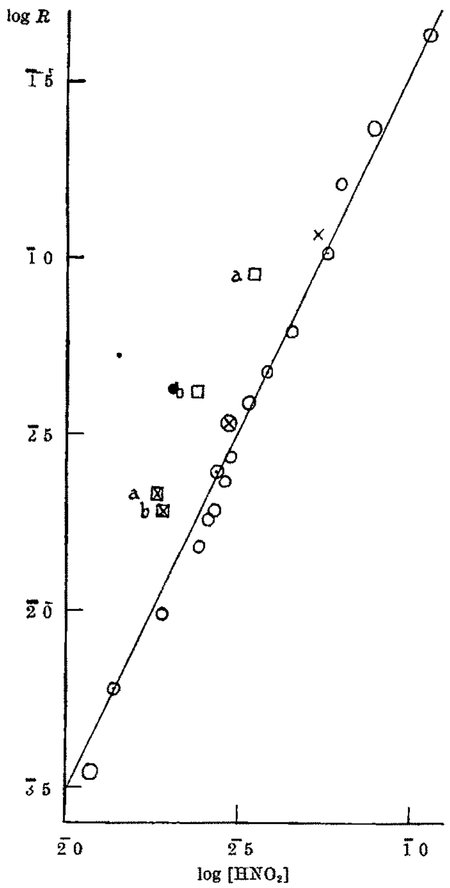
A distinction between some of these mechanisms can be made by following the dependence of exchange-rate on the concentration of nitrous acid It can readily be shown that exchange by reaction (1) will follow the kinetic law

$$\text{Rate} = k_2\,[HNO_2]^2,$$

where $[HNO_2]$ is the concentration of molecular nitrous acid , but that reactions (2) and (3) will give

$$\text{Rate} \propto [H^+]\,[HNO_2]$$

To allow the isolation of sufficient material for our isotopic analysis method, a solution of sodium nitrite (concentration varying between 0 4 and 1 *M*) was used, and to this was added not more than one-fifth the equivalent of perchloric acid. Under these conditions we can assume the concentration of molecular nitrous acid to be given by the stoichiometric



Dependence of exchange-rate on concentration of nitrous acid in absence and presence of other ions ○, no added ions, ⊗, [NO_3^-], 0 529 *M*, ×, [ClO_4^-], 0 445 *M*, ⊡, [Cl^-], (*a*) 2 36 *M*, (*b*) 2 31 *M*, ⊠, [Br^-], (*a*) 1 265 *M*; (*b*) 1 067 *M*

concentration of perchloric acid, after correcting for the initial decomposition of the nitrous acid

The relation between exchange-rate and concentration of nitrous acid is plotted logarithmically in Fig 1, and the straight line is drawn with a slope of 2 This clearly shows the dependence of exchange-rate on $[HNO_2]^2$, and the results do not fit the kinetic forms of reactions (2) and (3) We are able to show that under our conditions the addition of even high concentrations (*c.* 0 5 *M*) of sodium perchlorate and nitrate have no very marked effect on the exchange, but that the halide ions Cl^- and Br^- enhance the rate of exchange, presumably by the reaction

$$H_2N^+O_2 + X^- \rightleftharpoons NO - X + H_2O$$

(where X = Cl,Br), a reaction which is known to play a part in the halide ion catalysis of diazotization[1].

It is instructive to compare the values which we observe for k_2, the second-order rate coefficient for oxygen exchange with respect to HNO_2, with the second-order rate coefficient for diazotization under conditions in which the rate is independent of amine concentration The value of k_2 for oxygen exchange is 32 mol l $^{-1}$ min $^{-1}$, and that for diazotization (private communication, Hughes, Ingold and Ridd) is 40 mol. l $^{-1}$ min $^{-1}$ (this latter value is somewhat dependent upon the value taken for the dissociation constant of the nitrous acid, whereas the corresponding rate-coefficient for oxygen exchange is independent of this constant); we have calculated the diazotization-rate using the value of 3 2 × 10^{-4} mol. l.$^{-1}$, at 0 for the dissociation constant[2]. The agreement b tween these rates is reasonably close, particularly view of the widely differing reagent concentratio used (the diazotization experiments were carried o with reagent concentration *c* 10^{-3} *M*, private com munication, Hughes, Ingold and Ridd)

If we assume an exchange mechanism, under o experimental conditions, involving attack of nitrit ion on the nitrous acidium ion, we can use the dat of the halide ion catalysis to calculate the reactiviti of chloride and bromide ions, relative to nitrite io taken as unity, towards the nitrous acidium ion th values are Cl^-, 0 38, Br^-, 0 46. The value f bromide ion is, as expected, greater than for chloride and is comparable with the value of 0 54 obtaine by the measurement of bromide-ion catalysis diazotization (Hughes, Ingold and Ridd, privat communication) In the exchange measurements n correction has been made for any ionic strengt effect caused by the added halide ions

It is probable that at higher acid concentration the nitrite ion concentration will be reduced sufficiently to allow exchange by reactions (2) and (3 with a consequent change of kinetic form.

We are indebted to Profs E D Hughes and C. K Ingold, and to Dr. J H Ridd, for their advice an for their prior communication of their diazotizatio results

C A Bunton
D R Llewellyn
G Stedman

William Ramsay and Ralph Forster Laboratories,
University College,
London, W C 1

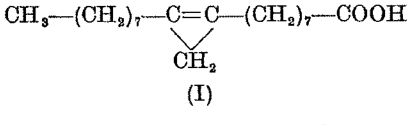
---

[1] Ingold, "Structure and Mechanism in Organic Chemistry", 38 (Bell, 1953)

[2] Klemenc and Hayek, *Monatsch*, 54, 407 (1929)

Structure of Sterculic Acid

The structure of sterculic acid, the major component of the kernel oil of *Sterculia foetida*, ha attracted the attention of various workers Hilditc *et al* [1] failed to isolate the acid but concluded fro the constants of the oil and the mixed methyl ester and some degradative experiments that it wa 12-methyl octadeca-9 11-dienoic acid Steger an Van Loon[2], working on the mixed fatty acids deduced that it was probably a hydroxy acid $C_{18}H_{34}O_3$ However, recently Nunn[3] has isolated th acid, $C_{19}H_{34}O_2$, by the method of urea complexes an suggested its structure as ω-(2*n*-octyl*cyclo*prop-1-enyl) octanoic acid (I)



$$CH_3-(CH_2)_7-\underset{\diagdown\;\diagup}{C=C}-(CH_2)_7-COOH \qquad \text{with } CH_2 \text{ bridging the two C}$$

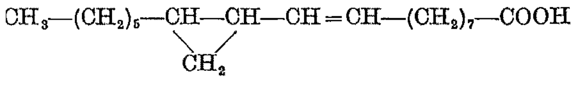
(I)

Nunn has based this structure mainly on the stron band at 9 8 μ in the infra-red spectrum of dihydro sterculic acid He has, however, not taken the infra red curve of the sterculic acid itself, and the positio of the double bond seems to have been fixed withou any supporting evidence

In this laboratory, sterculic acid has been separated from the mixed fatty acids by low-temperatur fractional crystallization in the colourless crystallin form, $C_{19}H_{34}O_2$ (m p 19°, n_D^{25} 1 4758) Its catalyti hydrogenation gives dihydro- and tetrahydro-sterculi acids, suggesting the presence of two, or the equivalent of two, double bonds

From the iodine value (98 2) and diene value (40 3), t may be inferred that these double bonds are probably conjugated, although the ultra-violet absorption spectrum does not show any band in the region 2200–3200 A The infra-red curve, however, gives clear indication of a *cyclo*propane ring at 9 96 μ and a double bond (C = C) at 6 09 μ on the shoulder of the strong carbonyl band at 5 9 μ

The *cyclo*propane ring exhibits typical unsaturation towards many specific additive reagents, as demonstrated by Kohler and Conant[4]. Therefore, the *cyclo*propane ring in sterculic acid may form a 'conjugated system' with the double bond, resulting in structure (II)



$$CH_3—(CH_2)_5—CH—CH—CH=CH—(CH_2)_7—COOH \quad (\text{bridge } CH_2)$$

(II)

Reduction and oxidation products obtained by various investigators[1,3] and also by us find ready explanation with this structure

Further, the synthesis of compound I has been effected from stearolic acid by the action of diazomethane This synthetic product gives an infra-red curve which is different from that of sterculic acid, thereby conclusively showing that the structure (I) is not correct

The details of this work will be published elsewhere

J. P. Verma
Bhola Nath
J. S Aggarwal

National Chemical Laboratory of India,
Poona 8
Sept 3

---

[1] Hilditch, Meara and Zaky, *J Soc Chem Indust*, **60**, 198T (1941)

[2] Steger and Van Loon, *Fette u Seifen* **50**, 305 (1943)

[3] Nunn, *J Chem Soc*, 313 (1952)

[4] Kohler and Conant, *J Amer Chem Soc*, **39**, 1404 (1917)

Separation of Saponins by Paper Chromatography

In the course of a study on the composition of saponins from Indian raw materials, difficulties were encountered in the complete separation of the glycosides in pure form by chemical means. The usual method of repeated precipitation with solvents is not dependable and does not ensure the chemical purity of the separated products, the more so because many of the saponins are hygroscopic

A convenient method of separation has now been developed by paper partition chromatography The spray reagent used was sodium periodate in alkaline permanganate solution, recently reported by Lemieux and Bauer[1] for the detection of carbohydrates, this has been found to be satisfactory in the case of saponins, giving permanent brown spots against a white background.

Qualitative characterization of the fairly pure saponins[2], isolated in this laboratory, was carried out on Whatman No. 1 filter-paper by the ascending method[3] with the system *n*-butanol – acetic acid – water (4 1 5) for 10–24 hr, and the dried papers were sprayed with a freshly prepared solution of sodium meta-periodate in alkaline potassium permanganate solution The papers were left for an appropriate time (5–6 min.) before they were washed with running water, when distinct brown spots of saponins appeared against the almost white background of the paper On drying, these spots remained unchanged for an indefinite period

Table 1

Saponins isolated from	No of saponins isolated by chemical method	No of saponins as shown by chromatography	R_F values
Entada scandens (Gila)	2	2	(1) 0 246 (2) 0 386
Balanites roxburghii (Hingora)			
Balanites roxburghii pericarp	1	1	0 202
Balanites roxburghii kernel	1	2	(1) 0 215 (2) 0 312
Sapindus trifoliatus (Ritha)	1	1	0 222
Bassia latifolia (Mahua)	1	1*	0 203

* One distinct spot and two indistinct spots on the strip

The R_F values found for the respective saponins are shown in Table 1 By employing this method, it has been possible to show that the saponins, purified by the usual chemical procedure, are in some cases actually composed of more than one saponin. Other solvent systems are being examined Details will be published elsewhere in due course.

N. L. Dutta

National Chemical Laboratory of India,
Poona, 8
Sept 10.

---

[1] Lemieux, R U, and Bauer, H F, *Anal Chem*, **26**, 920 (1954)

[2] Dutta, N L, *Curr Sci*, **23**, 222 (1954), *Pharm Acta Helv*, [**29**, 260 (1954)], *J Sci and Ind Res*, *India*, [**13B**, 672 (1954)]

[3] Partridge, *Biochem J* **42**, 238 (1948)

Techniques for labelling Trees with Radioactive Phosphorus

Insects feeding on plants in nutrient culture solution have been labelled with tracer-levels of radioactive isotopes in studies of insect feeding-habits[1] and insecticidal action[2]. Such insects have also been released in the field for population studies[3], and others fed on labelled artificial diets have been used in the study of insect metabolism[4].

To investigate the movement of the mealybug vectors of swollen shoot disease of cacao, techniques were studied for obtaining radioactive trees for the subsequent labelling of insects at their feeding sites under field conditions The artificial release of labelled insects in the field is unsatisfactory for such investigations

By the first method a panel of bark was removed from the stem of *Abutilon* sp. and 1 5 mc of phosphorus-32 in a volume of 3 ml held in a 'Plasticine' cup was introduced laterally through the severed conducting vessels After 24 hr, leaves 4 ft above the area of introduction provided 300 counts/min /sq cm, and after 48 hr nymphs of *Dysdercus* sp feeding 5 ft above the place of injection provided 12–346 counts/min This technique has been used successfully in translocation studies with dyes[5], and the resulting mechanical damage to the tree is small The amount of radiophosphorus translocated is uncertain because of the high residual activity on the 'Plasticine' cup. With high levels of activity, this technique presents some radiation hazard in the field Fig 1 shows that

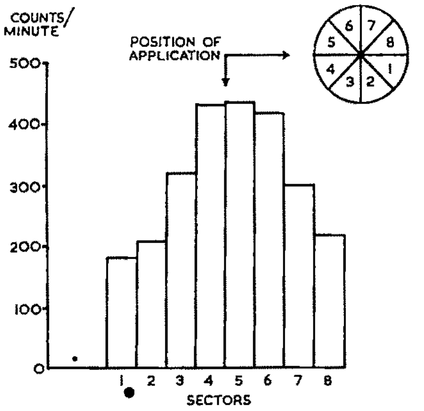


Fig 1 Activity distribution on the cross-section of the trunk of *Abutilon* sp 1 ft above the position of application

fourteen days after application the activity remained localized on that side of the stem at which the radiophosphorus was introduced

In the second method, 5 mc of phosphorus-32 in 10 ml. of solution was introduced through a glass tube sealed with 'Picine' wax into a small hole at the base of a young *Syringa vulgaris* L Fig. 2 shows the activities recorded from 1 5 cm leaf disks cut on the main veins of opposite leaves 4 ft above the point of introduction and 24 hr. after uptake of the active solution. The distribution of activity within the tree was very localized, but adult mealybugs (*Planococcus citri* (Risso)) fed for seven days on young shoots gave counts of 13–42/min. This technique produces little mechanical damage to the tree, but minor leakages are difficult to eliminate. The efficiency of this technique may undoubtedly be improved by the methods employed for diagnosing mineral deficiencies[6,7]

By a third method, 1 mc in 0 7 ml and 9 mc in 1 5 ml of solution of phosphorus-32 was introduced into two Douglas firs (*Pseudotsuga taxifolia* (Poir) Britt) by trunk implantation Such techniques have been used in studies with systemic insecticides[8] Th glass ampoules containing the active solutions we inserted into 1-in holes in the trunks and were the broken within the trees by knocking in tight-fitti wooden plugs Eight days after implantation, tot activities were recorded on the cut ends of 2-f lengths of trunk at various elevations (Table 1 Activities were also recorded on the trunk surfa of the tree implanted with 9 mc (Table 2), th was not possible with the tree implanted with 1 mc but 15 counts/sec were recorded at the tips of later branches at about 15 ft above the ground.

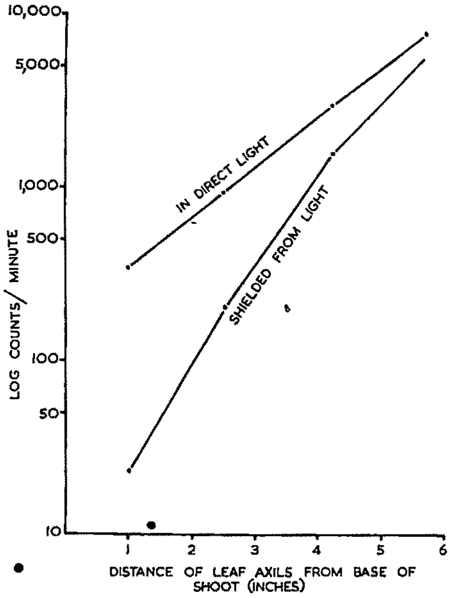


Fig 2 Activities from 1 5 cm diameter leaf disks cut on the main veins of opposite leaves of a young shoot of *Syringa vulgaris* L 24 hr after the introduction of 5 mc of phosphorus-32

Table 1 Counts per sec recorded on the Cut Ends of t Trunks of *Pseudotsuga taxifolia* (Poir) Britt implanted wi 1 mc and 9 mc of Phosphorus-32

Height above ground (ft)	Dose			
	9 mc		1 mc	
	Trunk diameter (in)	counts/sec	Trunk diameter (in)	counts/sec
4	3 3	300	3 7	80
6	3 1	500	3 5	4
8	3 0	350	3 5	12
10	2 9	150	3 5	50
12	2 8	100	3 5	20
14	2 5	200	3 0 2 0	30 ≏ Bg
16	2 0	80	3 0 1 5 1 5	18 ≏ Bg ≏ Bg
18	1 8	90	1 8 2 1	7 ≏ Bg
20	1 4	100	1 5 2 0	5 ≏ Bg
22	1 0	60		
24	0 6	7		
26	0 4	2		

≏ Bg = counts approximating to background-level (3 counts/se

Table 2 Counts per sec recorded on the Trunk Surface *Pseudotsuga taxifolia* (Poir) Britt implanted with 9 mc Phosphorus-32

Height above ground (ft)	Surface			
	Front	Left	Back	Right
3	≏ ∞ position of implantation	> 2,000	80	> 2,000
5	7	≏ Bg	≏ Bg	70
7	10	≏ Bg	≏ Bg	70
9	≏ Bg	≏ Bg	≏ Bg	400
11	11	≏ Bg	≏ Bg	400
13	3	≏ Bg	7	170
15	5	1	40	140
17	3	12	100	120
19	7	60	110	90
21	7	50	90	50
23	12	50	60	40
25	5	2	2	4
Growing tip, ≏ Bg	Tips of lateral branches, 0–80			

≏ Bg = counts approximating to background-level (3 counts/sec

In both trees it was estimated that about 95 p cent of the activity remained at the position implantation Table 1 indicates the localization activity at certain levels and in certain branches the main trunk Table 2 indicates a marked localiz tion on one side of the trunk, particularly so at t 9–11 ft level, at which region there is a decrease total activity recorded on the cut ends It is eviden therefore, that at this level the path of translocatio approaches the surface of the trunk and that high measurements result from a decrease in absorptio thickness of the wood

The trees appeared normally healthy at the tin of felling. This technique reduces radiation haza in the field to a minimum The sizes of hole an ampoule do not permit the use of large volumes active solution or phosphate carrier which mig assist in translocation from the position of implantation.

The methods described are suitable for obtaining radioactive host plants of insect populations in the field All three techniques suffer from two disadvantages, namely, the translocation of phosphorus-32 from the point of application is small and the distribution of tracer within the tree is localized Similar results were obtained with calcium-45 and rubidium-86 injected into yellow birch[9] Future investigations will be directed towards methods of root application and the use of carriers to aid in tracer distribution Autoradiography will be used to elucidate the pattern of distribution within the conducting tissues

These experiments were initiated when I was at the Isotope School, Atomic Energy Research Establishment, Harwell, and I wish to thank Mr. R A Faires, of the School, for much valuable advice and help , also Dr Leyton, at the Forestry Department, Oxford, and Dr Scott Russell, Department of Agriculture, University of Oxford, for their interest in the work. This communication is published with the consent of the Director of the West African Cacao Research Institute, Gold Coast

P B CORNWELL

West African Cacao Research Institute,
P O Box 8,
Tafo, Gold Coast
Aug 3

Watson, M A , and Nixon, H L , *Ann App Biol* , **40**, 537 (1953)
David, W A L , *Ann App Biol* , **39**, 203 (1952)
Kettlewell, H B D , *Nature*, **170**, 584 (1952)
Winteringham, F P W , Loveday, P M , and Hellyer, G C , *J Biochem* , **55**, 33 (1953)
Preston, R D , "Movement of Water in Higher Plants", chapter 4, 257 (Amsterdam, 1952)
Roach, W A , Imp Bur Hort and Plant Crops, East Malling, Tech Comm No 10, 78 (1938)
Fennah R G , and Evans, H , Ann Rep Cacao Res , Trin (1945–51)
Hanna, A D , and Nicol, J , *Nature*, **173**, 731 (1954)
Fraser, D A , and Mawson, C A , *Canad J Bot* , **31**, 324 (1953)

Acceleration of Citrate Oxidation in Yeast by Aspartic Acid

CITRATE oxidation in cell-free extracts of *Saccharo-yces cerevisiae* has previously been reported to be timulated by a weakly basic factor present in boiled east juice[1] It was afterwards observed that mmonia accelerates citrate oxidation when added o the assay system for oxidation factor, and sig-ificant amounts of free ammonia were found in the oiled juice prepared from the D C L commercial akers' yeast investigated[2] In a further study of ifferent strains of yeast, high oxidation factor ctivity has now been observed in ammonia-free xtracts of Anheuser–Busch commercial bakers' east when added to a particulate-free enzyme from he same organism In these preparations all activity s due to free L-aspartic acid, present in a concentra-ion of 4 6 μM/gm yeast The end-product of citrate xidation in the presence of aspartic acid is glutamic cid The reaction requires the addition of di- or tri-yridine nucleotide coenzymes This is illustrated n Fig 1

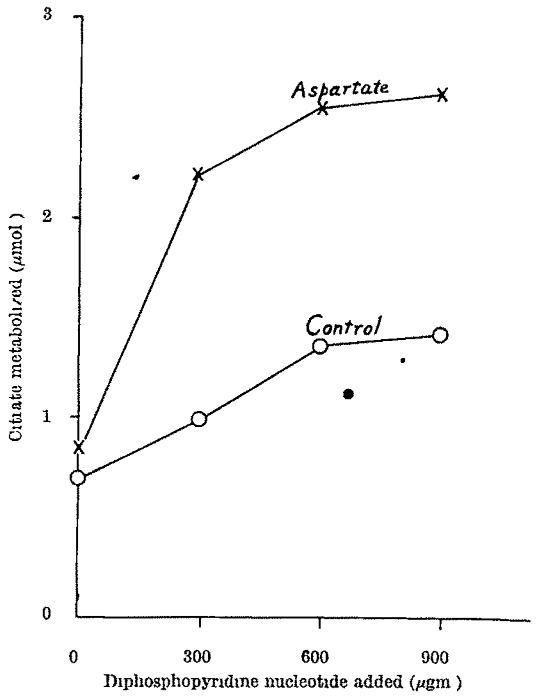


Fig 1 Dependence of the aspartate reaction on coenzyme Tube contents 4 μM citrate, 50 μgm magnesium, 0 3 ml enzyme dialysed 24 hr against 0 1 M potassium phosphate, pH 7 1, at 0° C , final vol 1 0 ml Incubation, 30 min at 37° C 2 μM L-aspartate added as indicated In the presence of excess di-pyridine nucleotide, 0 4 μM glutamate was formed in the control, and 2 2 μM in the presence of aspartate

Excess coenzyme does not inhibit the increased itrate oxidation in the presence of aspartate (aspart-te reaction) This clearly distinguishes the effect f aspartate in yeast from the effect in certain mam-nalian systems where aspartate can be shown to accelerate citrate oxidation by increasing the turnover of reduced coenzyme

The yeast enzyme actively catalyses the transamination reaction

$$\text{Aspartate} + \alpha\text{-oxoglutarate} \rightleftharpoons \text{oxalacetate} + \text{glutamate} \quad (1)$$

Any α-oxoglutarate formed from citrate in the presence of aspartate would react to form glutamic acid This reaction, however, cannot explain the stimulation of citrate oxidation by aspartate, as the breakdown of citrate to α-oxoglutarate is irreversible in the present system Nor do either aspartate or α-oxoglutarate affect any of the following enzymes involved in citrate oxidation aconitase, the *iso*citric dehydrogenases specific for di- and tri-pyridine nucleotide, and oxalosuccinic carboxylase The latter enzyme in all respects resembles the enzyme from pigeon breast muscle studied by Ochoa and Weisz-Tabori[3]

Further evidence against the participation of reaction (1) in the aspartate reaction is presented in Table 1

Table 1 CONDITIONS AS FOR FIG 1 L-GLUTAMATE (20 μM), OXALACETATE (5 μM) ADDED AS INDICATED

Additions	Citrate metabolized (μM)
—	1 47
Aspartate	2 73
Glutamate	1 33
Glutamate and aspartate	2 57
Oxalacetate	1 08
Oxalacetate and glutamate	3 07
Oxalacetate and aspartate	1 08

An excess of glutamic acid sufficient to prevent reaction (1) from proceeding to the right has no appreciable effect on the aspartate reaction Glutamate + oxalacetate simulate the effect of aspartate, presumably by giving rise to aspartate The strong inhibitory action of oxalacetate would be expected on the basis of reaction (1) or any other transamination reaction of aspartate.

In agreement with previous results[4], the aspartate reaction, like other transaminations, is inhibited by high concentrations of cyanide. Pyridoxal phosphate causes no stimulation. The nature of the transamination involved in the aspartate reaction remains unknown. Ammonia, which activates citrate oxidation in both the D.C.L. and the Anheuser–Busch strains of yeast, probably acts by a mechanism similar to the aspartate reaction.

This work was supported by grants from the J. C. R. Libson Fellowship and the Damon Runyon Memorial Fund for Cancer Research.

E. C. Foulkes

May Institute for Medical Research,
Jewish Hospital Association,
Cincinnati, Ohio.
Sept. 14.

[1] Foulkes, E. C., *Biochem. J.*, 54, 323 (1953).
[2] Whitehouse, M. W., Kent, P. W., Peters, R. A., and Foulkes, E. C., *Biochem. J.*, [58, 437 (1954)].
[3] Ochoa, S., and Weisz-Tabori, E., *J. Biol. Chem.*, 174, 123 (1948).
[4] Foulkes, E. C., *Fed. Proc.*, 12, 203 (1953).

Distribution of Adrenaline and Noradrenaline in the Adrenal Medulla

In previous papers[1], I have described two histochemically different types of chromaffin cells in the adrenal medulla of the rat. Adrenal medullas of several species have now been studied using the same histochemical methods, and adrenaline and noradrenaline determinations made[2]. The presence of brightly fluorescing cell groups against a dark background of non-fluorescing medullary cells was a constant finding in formalin-fixed sections of the adrenals of most species. Table 1 shows the proportions covered by fluorescing islets and the percentage amounts of noradrenaline in adrenal medullas of different species. Good correlation between the islet content and the noradrenaline content is obvious.

Table 1

Species	Noradrenaline content (% of both catechols)	Fluorescing tissue (% of whole medulla)
Cat	35–60	*c.* 50
Dog	20–40	*c.* 40
Hamster	25–40	*c.* 30
Mouse	15–35	*c.* 25
Rat	10–20	*c.* 15
Guinea pig	5	+?
Rabbit	3	0

In order to study the effect of adreno-medullary stimulation, male rats were injected subcutaneously with insulin (0·6 I.U./100 gm. body-weight at 9 a.m., the same dose at 12 o'clock, killed at 4 p.m.), or with nicotine (*c.* 1 mgm./100 gm. body-weight, killed ½–24 hr. later). Chronic overdosage of nicotine was caused by injecting 2–4 mgm. of nicotine daily for about 6½ months; these rats were killed about two weeks after the last injection. The results are summarized in Fig. 1, which shows that insulin causes a selective depletion of adrenaline and disappearance of the chromaffin reaction from all but some medullary cells, which form islets closely similar to the fluorescing islets. The fluorescence of these islets was not affected by insulin. After a single injection of nicotine, on the contrary, a selective loss of noradrenaline and disappearance of fluorescing and chromaffin materials from the 'islet' cells were observed. However, the response was somewhat variable. Prolonged treatment with nicotine caused a medullary hyperplasia associated with a pronounced increase in the relative amount of fluorescing medullary tissue and in the noradrenaline content. All these observations suggest that the two kinds of medullary cells bear specific relations to the storage and secretion of the two kinds of adreno-medullary hormones, a view already put forward in the earlier papers[1].

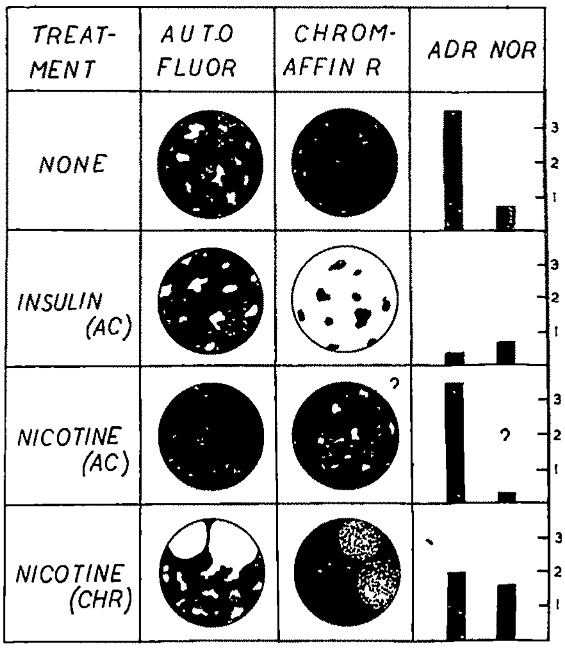


Fig. 1. Schematic illustration of the effects of insulin and nicotine on the histochemistry and catechol amine content of rat adrenal medulla. Distribution of fluorescing substances in the formalin-fixed sections is indicated in white; chromaffin materials are shown as black. The heights of the columns on the right refer to adrenaline and noradrenaline concentrations, expressed as per cent of dry medullary tissue. *AC* = acute; *CHR* = chronic.

The problem was investigated more directly in the cat and the hamster. Serial sections were prepared of fresh-frozen glands. Every other section was fixed in formalin and examined for the distribution of the fluorescing islets, and the alternate sections were freeze-dried. Information obtained from neighbouring formalin-fixed sections was used to dissect small pieces of the freeze-dried sections with variable proportions of fluorescing tissue. A piece with much fluorescing tissue always contained a higher proportion of noradrenaline than a piece with little islet tissue, taken from the same section. Small amounts of noradrenaline were nevertheless regularly found in pieces supposed to contain no fluorescing cells. The fluorescing islets were too small to allow mechanical separation of pieces containing exclusively fluorescing cells. Pieces with *c.* 70 per cent of islet tissue were found to contain approximately the same proportion of noradrenaline.

The observations indicate that some adreno-medullary cells contain much adrenaline and little noradrenaline, whereas other cells—which can be demonstrated by fluorescence microscopy of formalin fixed sections—contain predominantly or exclusively noradrenaline. The fact that noradrenaline forms a strongly fluorescing, poorly water-soluble substance with formalin, which adrenaline does not, suggests at formalin fixation is a kind of histochemical ethod for the selective demonstration of nor-lrenaline in the adrenal medulla, a point now under ore detailed study.

While this work was in progress, Hillarp and Hok-:t[3] described a technique for histochemical demon-ration of noradrenaline With this technique, using ffered potassium iodate, they also came to the nclusion that the two medullary catechol amines e stored in two different kinds of cells

I am grateful to Prof J H Gaddum and to Di. aithe Vogt for their guidance and laboiatory cilities during the academic year 1952–53, which I ent in the Department of Pharmacology, University Edinburgh

O Eranko

stitute of Occupational Health,
Tyoterveyslaitos, Helsinki
Nov 12

---

[1] ränkö, O , *Nature*, 168, 250 (1951), *Acta Anat*, 16, Supp 17 (1952)

[2] ränko, O (in course of publication)

[3] illarp, N -Å , and Hokfelt, B , *Acta Physiol Scand*, 30, 56 (1953) *Endocrinol*, 55, 255 (1954)

Cyanide-resistant Mitochondria from the Spadix of an *Arum*

Highly active preparations of mitochondria have en obtained from the spadix of *Arum maculatum*[1] iese exhibited the ability to oxidize acids of the :ebs's cycle and pyruvic acid in their presence No rrier needed to be added and the terminal oxidase sponsible for the oxidations was not identified The spiration of slices of spadix is not inhibited by anide[2], even though it is very rapid, with Q_{O_2} rising 31 8. As mitochondria are generally supposed to omote respiratory oxidations through their con-ned cytochromes, the reaction of these aroid tochondria to cyanide is of obvious interest

Using the method of Hackett and Simon, we were le to prepare mitochondrial suspensions of high tivity The extraction and suspension medium ntained 0 05 *M* phosphate buffer, *p*H 7 1, 0 2 *M* :rose, and 0 001 *M* magnesium sulphate, before ygen uptake was measured, 0 0004 *M* adenosine phosphate was added Endogenous respiration in is medium was virtually nil in all preparations ldition of citrate, α-ketoglutarate or succinate at)2 *M* concentration caused rapid uptake of oxygen)02 *M* Pyruvate in the presence of 0 002 *M* malate s also oxidized

After two hours incubation at 20° C the contents the manometer flasks containing no substrate and th α-ketoglutarate added were examined for acid mation by paper chromatography 1-ml aliquots m each were deproteinized with 2 volumes of ianol, and the dried supernatants, after acidifying th hydrochloric acid, were extracted with six lots 10 ml of ether The ether extracts were run two-dimensional chromatograms using ethanol-ammonia and mesityl oxide – formic acid as solvents[3]. After spraying the dried papers with bromo-phenol blue, no acids could be detected in the control experiment, but large amounts of citrate, malate succinate and fumarate had been formed during the incubation with α-ketoglutarate, as shown in Fig 1 All the α-ketoglutarate added had been oxidized

ble 1 1 ml Mitochondrial Suspension = 2 gm Fresh Weight of Tissue Total Volume, 30 ml T = 20° C

Substrate	Oxygen uptake (µl) in 15 min	Hydrogen cyanide added
Nil	0	—
Citrate	150	151
α-Ketoglutarate	293	(291)
Succinate	388	365
Pyruvate + malate	115	—

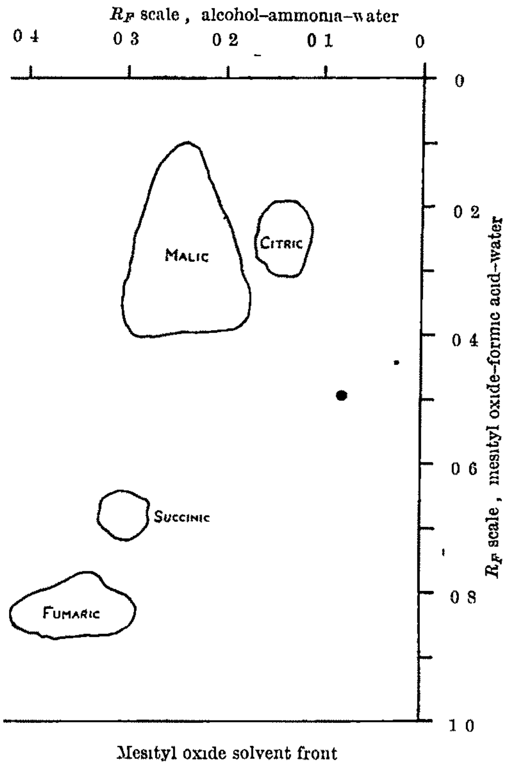


Fig 1

Addition of 0 001 *M* hydrogen cyanide with the substrate caused no inhibition of oxygen uptake in the presence of citrate or succinate during the first 15 min. There was no inhibition in the presence of α-ketoglutarate, and the pattern of acid formation was not changed either, but here the cyanide would probably be removed as cyanhydrin of the keto-acid present in large excess

After longer periods partial inhibition slowly developed in the presence of succinate After two hours it amounted to about 60 per cent, but by this time the rate in the control sample had itself fallen away considerably In the presence of citrate no inhibition or slowing down had appeared after 55 min

These experiments appear to confirm the suggestion that the mitochondria of *Arum* spadix are able to catalyse a Krebs's cycle of reactions, but they also indicate that at least some of the oxidations on which it is based are not inhibited by 0 001 *M* cyanide The partial inhibition that develops slowly in the presence of succinate is very different from the rapid and complete inhibition of the usual metallic oxidases

W O. James
Daphne C Elliott

Department of Botany,
University of Oxford
Oct 29.

---

[1] Hackett, D P, and Simon, E W, *Nature*, 173, 162 (1954)

[2] James, W O, and Beevers, H, *New Phytol*, 49, 353 (1950)

[3] Elliott, D C, *J Exp Bot* (in the press)

Chelated Iron Compounds for the Correction of Lime-induced Chlorosis in Fruit

LIME-INDUCED chlorosis of fruit trees is a serious problem on calcareous soils in Great Britain, and until recently the only practical means of correcting this disorder was a combination of grass cover and trunk injection of iron salts. The injection method is laborious, transient in effect and often causes severe damage to the trunk, especially to *Prunus* species Soil treatment with iron salts has not been effective owing to precipitation of iron in the soil

A new approach to the problem followed the discovery by Jacobson[1] in 1950 that ferric dipotassium ethylenediamine-tetraacetate (Fe-EDTA) was a satisfactory source of iron for plants growing in culture solutions at high *p*H In 1952 Stewart and Leonard[2] showed that 10–20 gm of chelated iron per tree (as ferric dipotassium ethylenediamine-tetraacetate) would control iron chlorosis (copper-induced) of citrus trees growing in acid soils Under alkaline conditions, as much as 100–300 gm of chelated iron per tree was necessary to control lime-induced chlorosis[3] The authors considered that such large amounts might render the method impracticable for field use

Recently, two new chelating agents for trivalent iron have been described by Chaberek and Bersworth[4] They are N,N′-dihydroxyethylethylenediamine-diacetic acid (HEEDDA) and N-hydroxyethylethylenediamine-triacetic acid (HEEDTA) The iron chelates of these two acids, together with that of diethylenetriamine-pentaacetic acid (DTPA), have been shown by Wallace *et al* [5] to be more effective in correcting lime-induced chlorosis of ornamental trees than ferric dipotassium ethylenediamine-tetraacetate

In 1953 small-scale field-trials were started by us to test the effect of ferric disodium ethylenediamine-tetraacetate, as soil dressings and foliage sprays, on lime-induced chlorosis in red currants, plums and pears Rates of soil dressings were based on the early work of Stewart and Leonard (*loc cit*) for citrus in acid soils These rates proved ineffective under the alkaline soil conditions The foliage sprays showed promise and no damage occurred on plum and red currant at concentrations of 0 1 per cent or less An account of these preliminary trials has been given by Bould[6]

Further experiments were made in 1954 on pe and plum growing in a highly calcareous soil of p 7 8, using increased rates of application of fer disodium ethylenediamine-tetraacetate as a s dressing, and also varying rates of ferric diethylen triamine-pentaacetate and ferric N-hydroxyeth ethylenediamine-triacetate For pear the chelat were applied in solution around the trees (within circle of 6 ft diameter) and thoroughly watered Soil treatments and foliage sprays were also appli to chlorotic plum trees, var Burbank's Giant Prun The ferric-ethylenediamine-tetraacetate was broadc on April 6 around the trees, within a circle of 12 diameter, at the rate of 16 oz per tree (avera height 12 ft and girth 12 in) and lightly watered the ferric N-hydroxyethylethylenediamine-triaceta was applied in a similar manner at 12 oz and 16 per tree

Foliage sprays of both these salts and also of fer diethylenetriamine-pentaacetate, at 0 1 per ce concentration plus a wetting agent, were applied plums on three successive occasions at petal-f and after two fortnightly intervals

At another centre one foliage spray of fer diethylenetriamine-pentaacetate, at 0 1 per ce concentration plus a wetting agent, was applied extremely chlorotic peach trees on June 29

The treatments, rates of application, and effec on chlorosis and extension growth of pear are sur marized in Table 1 Ferric disodium ethylenediamin tetraacetate and ferric diethylenetriamine-pent acetate at 8 oz per tree gave a complete control chlorosis and resulted in vigorous extension growt This is the first recorded response by fruit trees Great Britain to soil treatments There was observable response to the ferric N-hydroxyethy ethylenediamine-triacetate, but it should be point out that the dressings of this compound suppli much less chelated iron than the other two, a further tests are needed

The plum trees did not respond to the s treatments This may have been due to t failure of the iron chelates to penetrate to t plum roots The chelates were not thorough watered in as for pear, and a dry period follow application

The foliage sprays on plum gave a commerc control of chlorosis, and, with the exception of fer disodium ethylenediamine-tetraacetate which pr duced a little marginal and tip scorch, caused damage

Table 1 EFFECT OF SOIL DRESSINGS OF CHELATED IRON ON THE INCIDENCE OF LIME-INDUCED CHLOROSIS IN PEAR *var* CONFERENCE O QUINCE ROOTSTOCK

Soil treatment	Amount of chelated iron (gm)	Date applied	Tree height (ft)	Tree girth (in)	Chlorosis 11–8–54	Extension growth 11–8–54
8 oz Fe-EDTA per tree	32 0	6–4–54	5½	7½	Nil	Very good
12 oz Fe-EDTA per tree	48 0	6–4–54	5	7	Nil	Very good
4 oz Fe-HEEDTA per tree (absorbed on vermiculite)	3 4	6–4–54	4½	7½	Severe with necrosis	Poor–medium
6 oz Fe-HEEDTA per tree	5 1	6–4–54	4	5½	Very severe with necrosis	Poor–medium
8 oz Fe-HEEDTA per tree	6 8	6–4–54	4½	5	Medium–severe	Medium
Controls	—	—	—	—	Very severe with necrosis	Poor–medium
4 oz Fe-DTPA per tree	11 4	11–5–54	5	5½	Slight	Medium
6 oz Fe-DTPA per tree	17 1	11–5–54	4½	5	Trace	Good
8 oz Fe-DTPA per tree	22 8	11–5–54	6	7	Nil	Very good
Controls	—	—	—	—	Very severe	Poor
45 ml Fe-HEEDTA per tree (liquid)	1 6	2–6–54	5	5½	Very severe with necrosis	Very poor
75 ml Fe-HEEDTA per tree	2 6	2–6–54	5½	5½	Medium severe	Poor
150 ml Fe-HEEDTA per tree	5 3	2–6–54	6	5½	Severe	Poor
200 ml Fe-HEEDTA per tree	7 0	2–6–54	6	5½	Medium severe	Good
Controls	—	—	—	—	Very severe	Very poor

Three weeks after applying a single foliage spray of
ric diethylenetriamine-pentaacetate to peach trees,
e chlorosis had almost completely disappeared and
e leaves have remained green until the present
te

These results indicate that control of lime-induced
n chlorosis in fruit trees is possible by soil treat-
nt, providing sufficient iron chelate is used and it
transported to the absorbing roots by rain or heavy
tering The cost of adequate soil dressings of
elates may prove uneconomic on a commercial
le for certain fruit crops For plums and peaches
e foliage spray method appears to give a satis-
ctory control of chlorosis, during the season of
plication, at a much lower cost Pear leaves are
re difficult to wet and they are damaged more
sily than plum, apple and peach

The full results of these and of further experiments
ll be reported elsewhere

C BOULD

ng Ashton Research Station,
Bristol
Sept 14

---

acobson, L, *Plant Physiol*, **26**, 411 (1951)
ewart, I, and Leonard, C D, *Citrus Mag*, **14**, 22 (1952)
eonard, C D, and Stewart, I, *Proc Amer Soc Hort Sci*, **62**, 103 (1953)
haberek, S, and Bersworth, F C, *Science*, **118**, 280 (1953)
allace, A, North, C P, Kofranek, A M, and Lunt, O R, *Calif Agric*, **6**, 13 (1953)
ould, C, Ann Rep Long Ashton Res Sta 1953, p 91

Acarine Disease of the Honeybee and Temperature

IT has been suggested from time to time that there
ay be relationships between acarine disease of
neybees and weather or other environmental
ctors, but such a view has also often received
rongly reasoned opposition, as by Phillips[1] and
orgenthaler[2], and no reliable relationship with a
ather factor has so far been forthcoming

I have now found that if the areas between January
otherms for 27° F and 54° F actual temperatures
the northern hemisphere are shaded, upon a map
the world, and areas between July isotherms for
° F and 66° F are shaded the other way upon the
ap, the two sets of shadings are found in super-
sition in Britain and adjacent parts of Europe,
d the doubly shaded areas correspond fairly closely
ith the main areas in Europe in which acarine
sease is found Over the rest of the world (using
e corresponding July and January isotherms
spectively in the southern hemisphere) such overlap
curs only in a few limited areas One of these
eas is in Argentina, in which country acarine
sease has been found In North America—reported
have no acarine disease—there is no overlap except
a very limited area on the extreme west Asia, in
ost areas substantially without acarine disease, and
frica and Australia, from which the disease has not
en reported, show only very small localized areas
overlap

The theory is advanced that acarine disease is
und only where overlap of these two temperature
nds occurs, and that the areas where the two bands
oss most centrally (as in Britain) are the areas of
ghest infestation New Zealand shows marked
erlap, particularly in the south, and on this theory
uld harbour acarine disease if it were introduced, though so far the disease has not been reported from that country

It is suggested that the action of high summer temperature in reducing the disease incidence is probably based on the faster working and shorter life-span of the worker bees which obtains under the more favourable foraging conditions, and which gives the mite less time to reach maturity and migrate from bee to bee, the low summer limit apparently coincides rather closely with the temperature limit for effective survival of the honeybee colony itself The action of low winter temperature in reducing the incidence of disease may be partly due to the disturbed state of a diseased winter cluster, rendering it less able to survive the severe conditions of a cold winter, while the high winter limit may be principally a reflexion of the relatively high summer temperature which, for physical reasons, in temperate zones, apparently almost always accompanies it

Many significant direct correlations between acarine incidence and temperature have been obtained in the course of this work, for example, a coefficient of $-0\ 50$ (50 degrees of freedom, $P < 0\ 001$) for acarine disease and summer temperature in fifty-two counties in England and Wales on data by Butler[3], and a coefficient of $+ 0\ 51$ (20 degrees of freedom, $P < 0\ 02$) for acarine disease and winter temperature for twenty-two years on data for Britain by Morison[4], as well as highly significant correlations between incidence of acarine disease and January–July temperature-range, on either Butler's or Morison's data taken separately, and also between acarine disease and suitably selected phenological criteria on either of the above sets of data It has been found that the above correlations with summer and winter temperatures can be drawn together mathematically into a single working hypothesis, which in operation corresponds closely with the overlap of the isotherm ranges suggested above

Calculations based on this hypothesis, using temperatures prevailing in Britain in the appropriate years, agree with the timing of the severe epidemic of acarine disease in Britain between about 1904 and 1919, as well as the reduction in its incidence (evident in Morison's data) at the present time They are also in agreement with the higher incidence of acarine disease in Scotland than in England (also seen in Morison's data) and, when calculations are based on temperatures in Switzerland, with the much lower incidence in that country (Morgenthaler[5]) The calculations show that at the temperatures of the major areas of North America, Africa and Australia, as well as most of Asia, the disease, on this hypothesis, would be unable to maintain itself

I wish to thank Principal M A H Tincker and Dr G D Morison, of this College, for encouragement, Dr F H C Marriott, of the University of Aberdeen, for statistical advice, and Dr C B Williams, of the Entomological Department, Rothamsted Experimental Station, for constructive criticism Further details of this work will be published in due course

E P JEFFREE

Bee Research Department,
North of Scotland College of Agriculture,
Aberdeen
Sept 10

---

[1] Phillips, E F, U S Dept Agr Circ, **218**, 7 (1922)
[2] Morgenthaler, O, *Z angew Ent*, **19**, 459 (1932)
[3] Butler, C G, *Ann App Biol*, **32**, 344 (1945)
[4] Morison, G D, Jeffree, E P, Murray, L, and Allen, M D (awaiting publication)
[5] Morgenthaler, O, *Beih Schweiz Bienenztg*, **1**, 285 (1944)

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, January 10

ASSOCIATION OF CLINICAL BIOCHEMISTS, SOUTHERN REGION (at University College Hospital, Gower Street, London, W C 1), at 3 15 p m —Annual General Meeting, 4 30 p m —Scientific Papers

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on "Atmospheric Pollution"

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5 45 p m — Sir Geoffrey Vickers, V C "Some Meanings of Progress" (Wilde Memorial Lecture)

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Chemical Society Burlington House, Piccadilly, London, W 1), at 6 30 p m — Dr F Ehrmann "Trends in the German Chemical Industry Since the War"

ROYAL GEOGRAPHICAL SOCIETY (joint meeting with the ALPINE CLUB, at 1 Kensington Gore, London, S W 7), at 8 30 p m —Prof Ardito Desio "Ascent of K 2" (Dickson Asia Lecture)

Tuesday, January 11

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Dr J C Fidler "Volatiles", Mr R A K Long "Some Thermodynamic Properties of Fish and their Effect on the Rate of Freezing"

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 6 p m —Mr B S Cooper "Fading and Related Effects Associated with the Radiation from Light Sources"

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Dr D Cleverdon, Mr L Harvey, Mr P G Smith and Mrs D Laker "Measurement of Molecular Weight by the Light Scattering Method" (Paper will be read by Dr Cleverdon)

Wednesday, January 12

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (joint meeting with the SOCIETY FOR APPLIED BACTERIOLOGY, at the Institution of Civil Engineers, Great George Street, Westminster, London, S W 1), at 2 15 p m —Meeting on "Aeration in Industrial Fermentations"

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 5 p m —Prof T Neville George "Carboniferous Main Limestone of the East Crop in South Wales", Mr T N Clifford "The Stratigraphy and Structure of Part of the Kintail District of Southern Ross-shire, its Relation to the Northern Highlands"

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W C 2), at 5 30 p m —Mr E G Rowe, Mr P Welch and Mr W W Wright "Thermionic Valves of Improved Quality for Government and Industrial Purposes"

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m — Prof C Tyler "The Chemical, Physical and Structural Characteristics of Egg Shells"

Thursday, January 13

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Science Museum Lecture Theatre, Exhibition Road, London, S W 7) at 4 30 p m —Mr W A Levick "The Petrochemicals Low Temperature Gas Separation Column"

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 5 30 p m —Mr W F Cartwright "Integration in the Iron and Steel Industry" *

Friday, January 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Scientific Papers

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W C 2), at 7 p m. —Dr H S Turner "The Synthesis of Radiochemically Labelled Fine Chemicals"

Saturday, January 15

BIOCHEMICAL SOCIETY (in the Physiology and Biochemistry Department, King's College, Strand, London, W C 2), at 2 p m —Scientific Papers

---

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

ASSISTANT EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (with a degree in chemistry or physics or the N D D T) IN THE TECHNICAL CHEMISTRY DEPARTMENT, for work on the manufacture and analysis of milk powders and evaporated milk—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (January 15)

JUNIOR ASSISTANT CHEMISTS (with a B Sc degree or equivalent, and preferably with some experience in fuel technology) in the Central Laboratories, South-Eastern Gas Board, 709 Old Kent Road, London, S E 15—The Personnel Manager, South-Eastern Gas Board, Katharine Street, Croydon, quoting V 28/488 (January 15)

LECTURER IN THEORETICAL PHYSICS—The Registrar, The Ur
sity, Reading (January 17)

LECTURER/SENIOR LECTURER (preferably interested in undert
genecological or cytogenetic studies on the Australian flor
BOTANY, at the University of Sydney, Australia—The Secre
Association of Universities of the British Commonwealth, 5 G
Square, London, W C 1 (Australia, January 19)

SCIENTIFIC OFFICER, Grade I (with a university degree of
standard in physics or equivalent qualifications, and preferably
experience in optical instrumentation) in the Department of Su
High-Speed Aerodynamics Division, Aeronautical Research
oratories (Instrumentation Section), Salisbury, South Australia
the development and design of general physical and particu
optical instruments for aerodynamics research—The Senior Repres
tive (A P 23), Department of Supply, Australia House, St
London, W C 2 (January 20)

PHYSICIST (with a good honours degree in physics or equiv
professional qualifications, and preferably with some experien
research and field experiments), at the Central Research Estal
ment, Isleworth, Middlesex, to carry out research on strata stud
The National Coal Board, Establishments (Personnel), Hobart H
Grosvenor Place, London, S W 1, quoting TT/900 (January 2

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFF
(with G C E advanced level in two scientific subjects or equiva
and ability to write clear, concise English and preferably with
knowledge of European languages) in the Department of Scie
and Industrial Research Food Investigation Headquarters, Cambr
for editorial duties on a journal of scientific and technical abst
and reviews on food science and technology—The Ministry of La
and National Service, Technical and Scientific Register (K), 26
Street, London, S W 1, quoting G 444/54A (January 22)

EXPERIMENTAL OFFICER (with a knowledge of organic chem
or biochemistry) IN THE DEPARTMENT OF INSECTICIDES AND FU
CIDES, to assist in the study of the mode of action of insectici
The Secretary Rothamsted Experimental Station, Harpenden, I
(January 22)

LECTURER (with a good honours degree in mechanical engine
or equivalent qualification, and practical experience in industry
in teaching) IN MECHANICAL ENGINEERING—The Principal, W
and District Mining and Technical College, Wigan (January 24)

ORGANIC CHEMIST (with an honours degree in science with org
chemistry as a major subject, and some postgraduate research
perience) IN THE DIVISION OF FOOD PRESERVATION AND TRANSP
Commonwealth Scientific and Industrial Research Organiza
Homebush, N S W , Australia, for investigations, with a small g
of chemists, on chemical reactions occurring on processed foods
during storage and on the chemical composition of the natural
ducts—The Chief Scientific Liaison Officer, Australian Scien
Liaison Office, Africa House, Kingsway, London, W C 2, quo
300/151 (January 29)

RESEARCH OFFICER (chemist) (with an honours degree in chemi
and preferably with research experience in the field of organic c
istry) IN THE BIOCHEMISTRY UNIT, Wool Textile Research Laborato
Commonwealth Scientific and Industrial Research Organiza
Melbourne, to develop specific reagents for the chemical modifica
of proteins and to study the effect of such reagents on the chen
and physical properties of wool keratin—Chief Scientific Lia
Officer, Australian Scientific Liaison Office, Africa House, Kings
London, W C 2, quoting 462/76 (January 29)

RESEARCH OFFICERS or SENIOR RESEARCH OFFICERS IN THE (
RESEARCH SECTION, Commonwealth Scientific and Industrial Rese
Organization, Sydney, Australia, for (*a*) to undertake investigat
of the chemical structure of Australian coals and assessment of
potential value to the chemical industry and, in particular, to exa
the behaviour of coals in various chemical reactions such as hy
genolysis or to study the chemical reactions occurring during
pyrolysis of coals (Ref 480/150), (*b*) to participate in the activ
of a group concerned with the studying of the mechanical prope
of coal and their industrial significance (Ref 480/153), and (
participate in studies being undertaken to evaluate combustion c
acteristics of Australian coals (Ref 480/154)—Chief Scientific Lia
Officer, Australian Scientific Liaison Office, Africa House, Kings
London, W C 2 (January 29)

ENTOMOLOGIST IN THE DEPARTMENT OF ENTOMOLOGY of the W
Agricultural Research Institute—The Registrar, The Univer
Adelaide, South Australia (January 31)

PROFESSOR OF EDUCATION at McGill University, Canada—
Secretary, Association of Universities of the British Commonwea
5 Gordon Square, London, W C 1 (January 31)

RESEARCH SCHOLAR IN THE DEPARTMENT OF CHEMISTRY—
Secretary, The University, Aberdeen (January 31)

SCIENTIFIC OFFICER, CHEMIST (with a first- or second-class hon
degree in chemistry or in a biological subject with chemistry a
additional subject, or equivalent qualification), at the Brown T
Research Laboratory Pitlochry, to be a member of a small t
investigating chemical problems of freshwaters, working in c
association with Biologists—The Establishment Officer, Scottish H
Department, Room 364, St Andrew's House, Edinburgh 1 (January

SENIOR LECTURER IN ZOOLOGY at the University of the Witwat
rand, Johannesburg, South Africa—The Secretary, Associatio
Universities of the British Commonwealth, 5 Gordon Square, Lon
W C 1 (South Africa, January 31)

SENIOR LECTURER IN ENGINEERING, a LECTURER IN PHYSICS,
a LECTURER IN BOTANY, at Fourah Bay College, Sierra Leone—
Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Squ
London, W C 1 (February 7)

LECTURER (Grade II) IN PHYSICS, and a RESEARCH FELLOW
PHYSICS—The Registrar, The University, Birmingham 15 (Fe
ary 15)

LECTURER IN EDUCATION at the University of Hong Kong—
Secretary, Association of Universities of the British Commonwea
5 Gordon Square, London, W C 1 (Hong Kong, February 15)

LECTURER or ASSISTANT LECTURER (with special interests in gene
or genecology) IN BOTANY—The Registrar, The University, Lee
(February 19)

PERMUTIT

ION EXCHANGE MATERIALS

The use of Permutit Ion Exchange Materials in many roles distinct from water treatment, has resulted in the development of numerous new industrial processes giving improved results and lower running costs Some materials now available are —

Zeo-Karb Na. A sulphonated coal product containing both strong and weak acid groups

Zeo-Karb 215. A nuclear sulphonated phenol resin containing also hydroxyl groups

Zeo-Karb 225. A unifunctional cross linked sulphonated polystyrene resin in bead form of high capacity and exceptional chemical and physical stability

Zeo-Karb 226. A unifunctional cross linked methacrylic acid resin in bead form containing only carboxyl groups as the ion active groups

De-Acidite E. A high capacity anion exchange material of medium basicity

De-Acidite FF. A unifunctional very highly basic anion exchange resin in bead form based on cross linked polystyrene and containing quaternary ammonium groups

De-Acidite G A unifunctional weakly basic anion exchange resin in bead form based on cross linked polystyrene and containing diethylamino groups

De-Acidite H A material similar to "De-Acidite G" but containing dimethylamino groups

Bio-Deminrolit A mixed cation and anion exchange resin for demineralisation in a single column

Decalso F. A synthetic sodium aluminium silicate suitable for the separation and concentration of vitamins and hormones

Decolorite. A resin of high porosity for removing colour from solutions.

Permaplex C-10. A highly selective cation exchange resin membrane containing SO_3H groups.

Permaplex A-10. A highly selective anion exchange resin membrane containing quaternary ammonium groups

For full technical information please write to THE PERMUTIT COMPANY LIMITED Head Office and Laboratories Dept V H 92, Permutit House, Gunnersbury Avenue, London, W 4 Telephone. CHIswick 6431

Permutit Ion Exchange Materials — Made in Britain by British Labour

GLASS

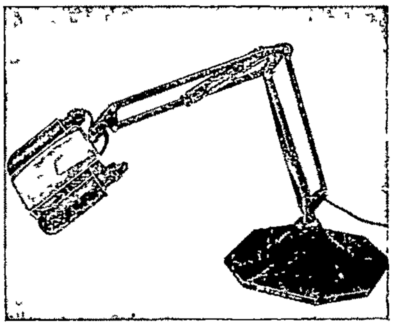
All Glass Requirements for Scientific Instrument Manufacturers and Research Workers

- SHEET & PLATE-GLASS—cut and ground to exact dimensions
- LENSES, PRISMS & FLATS—to any standard of accuracy
- MIRRORS—back silvered and front surface aluminised, etc
- BLOOMING of optical components

C. J. WHILEMS, LTD.
ILFORD OPTICAL WORKS
FOREST ROAD, BARKINGSIDE, ESSEX

Telephone HAInault 2554

Enbeeco
MAGNAPOISE ILLUMINATED MAGNIFIER



This new adjustable stand magnifier incorporates the well-known Anglepoise patented fittings, and brings adequate magnification and illumination to finger-tip command Its uses—like its angles—seem limitless

With the flick of a finger the lens is placed anywhere at any angle, in a position to "stay put" Here is a magnifier with adequate magnification and good field with the large rectangular lens 6″ × 3½″, combined with illumination provided by two "Pigmy" 15-watt lamps, one each side of the lens, as illustrated, and completely shielded from the viewing side, operated from mains voltage. The Magnapoise is free from sag or wobble, is unaffected by vibration, and will prove to be unsurpassed for use in the factory, laboratory, etc

Base, 11½″ across, is black featherweave finished with two adjustable arms fitted to a swivel fitting at the base, which allows every conceivable movement with perfect balance of the lens

PRICE £17 17s 0d

36 PAGE MAGNIFIER CATALOGUE
GLADLY SENT ON REQUEST

NEWBOLD & BULFORD LTD
ESTABLISHED 1796
Manufacturers and Exporters of Optical and Scientific Instruments and Ophthalmic Supplies etc.
ENBEECO HOUSE, ROGER ST, GRAYS INN RD., W.C.1.
TELEPHONE CHANCERY 5614 (3 LINES) TELEGRAMS: BULFORD, PHONE, LONDON

MANUFACTURERS "Enbeeco" PRODUCTS
DISTRIBUTORS LEECH PRODUCTS

LECTURES AND COURSES

UNIVERSITY COLLEGE
LONDON
COMMUNICATION RESEARCH CENTRE

Free Public Lectures at 5 30 p m in the Anatomy Theatre (Entrance Gower Street) Tuesday, January 25, "The Language of Neurology, its Advantages and Limitations," Professor J Z Young Tuesday, February 15, ' A Mathematical Model of Neuronal Interaction,' Mr W K Taylor Monday, February 28, ' Translation ' Dr E V Rieu Tuesday, March 15, "The Importance of Human Communication in Industry," Professor R W Russell

Details of all public lectures (including lunch-hour lectures) from Publications Officer, University College London, Gower Street, W C 1 (Stamped envelope required)

WOOLWICH POLYTECHNIC

Special Lectures in Higher Technology and Commerce

(a) AN INTRODUCTION TO SERVO-MECHANISMS
Six lectures commencing Wednesdav, February 2 from 7 0-9 0 p m
by K B REED B Sc (Eng), A M I E E

(b) INDUSTRIAL ELECTRONICS (including Associated Laboratory Practice)
Twenty-four lectures to be held on Mondays and Wednesdays commencing January 10 from 2 0-5 0 p m
by G L BIBBY, B Sc (Eng), and K B REED, B Sc (Eng), A M I E E

(c) INSECT PESTS AND FUNGAL DISEASES IN HORTICULTURE AND MARKET-GARDENING
Twenty-four lectures commencing Thursday, February 10, from 6 0-8 0 p m
by C S WOOD-BAKER, M Sc , Ph D , F Z S , F R E S

(d) APPEARANCE IN STRUCTURAL DESIGN
Four lectures commencing Tuesday, February 1 from 7 0-9 0 p m
by P HUDSON Dip Arch A R I B A

(e) OUTLINES OF THE LAW OF PATENTS AND DESIGNS FOR EXECUTIVES
Six fortnightly lectures commencing Thursday, January 20 from 7 0-9 0 p m
by ANTHONY WALTER Barrister-at-Law

(f) RECENT DEVELOPMENTS IN INDUSTRIAL LAW
Six lectures commencing Thursday, April 21 from 7 0-9 30 p m
by E F ARAGON, Barrister-at-Law

(g) COST ACCOUNTING FOR MANAGEMENT
Eight lectures commencing Wednesday January 19 from 7 0-9 30 p m
Lecturer to be announced later

FEES Course d £1 1 0 Courses a e, f, and g £2 2 0
Courses b and c £4 4 0

ENROLMENT By personal application from 9 0 a m to 8 30 p m or by postal application to the Secretary

UNIVERSITY COLLEGE OF SWANSEA

(A constituent College of the University of Wales)
Principal J S Fulton, M A

Courses of study are provided for (a) Degrees of the University of Wales in Arts, in Pure Science and in Applied Science (Metallurgy and Engineering) (b) The training of teachers for elementary and secondary schools (c) The first medical examination of the University of Wales (d) The first year of the course for the degree of *Baccalaureus in Architectura* (e) The Preliminary Part of the scheme of study for the degree of *Baccalaureus in Pharmacia* (f) A Diploma in Social Science (g) A Diploma in Youth Leadership and Organization College courses in Pure Science are recognized by a number of medical licensing bodies as constituting a first year of medical study The College maintains a Hall of Residence for women students Entrance scholarships are offered for competition in February each year

Particulars about admission to the College in October 1955, and of the entrance scholarships, may be obtained from the Registrar University College, Singleton Park Swansea

CHELSEA POLYTECHNIC
MANRESA ROAD S W 3
DEPARTMENT OF CHEMISTRY
SESSION 1954-55
POSTGRADUATE LECTURES IN BIOCHEMISTRY

Groups III and IV of the lectures on "Biochemistry" (each group comprising five lectures) will be given by Dr E M Crook, M Sc , Ph D , and Professor F L Warren, M A , D Sc , on Mondays, 7 15 to 8 30 p m , during the period January 10 to March 14, 1955 Group III will deal with "Digestion and metabolism of proteins and amino-acids," and Group IV with ' Digestion and metabolism of lipids and sterols " The lectures are a continuation of the course which commenced in October, 1954, and are designed for students who possess a knowledge of chemistry to degree standard Fee 10s for each group

Full particulars obtainable from the Secretary

UNIVERSITY OF LONDON

A course of three lectures on "Problems of Transport in Plants" will be given by Professor W H Arisz (Groningen) at 5 30 p m on January 17, 19 and 21 at University College (Anatomy Theatre), Gower Street, W C 1

Admission free without ticket

JAMES HENDERSON,
Academic Registrar

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
METALLURGIST RESEARCH OFFICER

Applications are invited for a post as Research Officer in the Mechanical Engineering Research Laboratory of the C S I R , Pretoria South Africa The salary scale associated with this post is £780 by £48 to £1,020 per annum In addition a cost-of-living allowance of £234 per annum is payable to married male officers Starting salary according to qualifications and experience Generous leave privileges and five-day week Candidates must be in possession of at least an honours degree in metallurgy or metallurgical engineering, or equivalent qualification The successful candidate will do research work in the field of ferrous and non-ferrous physical metallurgy The successful candidate will be required to furnish a medical certificate of good health and to become a member of the University Institutions Provident Fund The Council will bear the transportation costs of the appointee and his family from his place of residence to Pretoria Further information and application forms are obtainable from the South African Scientific Liaison Officer Africa House, Kingsway, London, W C 2

Applications, giving full details of age marital status qualifications, experience, and the names of referees must reach the Secretary/Treasurer, C S I R , P O Box 395, Pretoria, South Africa, before March 15, 1955 A copy of the application must be sent to the South African Liaison Officer in London

CENTRAL RESEARCH ESTABLISHMENT, National Coal Board (at Isleworth Middlesex) which is concerned with mining problems, invite applications for a superannuable appointment of a Physicist to carry out research on strata studies The work will be concerned initially with measurement of rock pressures Candidates should have a good honours degree in physics or equivalent professional qualifications and preferably some experience in research and field experiments Appointment will be according to qualifications and experience as either Scientist II (scale £800 by £35 to £1,150 male and £700 by £30 to £1 000 female) or Scientist III (scale £500 by £25 to £950 male and £475 by £20 to £835 female), London location allowance of £34 at the minimum rising to £82 at the maximum of the scales is payable in addition —Write giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1 marking envelope TT/900 Original testimonials should not be forwarded Closing date January 22, 1955

COMMONWEALTH of AUSTRALI
COMMONWEALTH SCIENTIFIC AND
INDUSTRIAL RESEARCH ORGANIZATI
APPOINTMENT NO 146/34 OF RESEAR
OFFICER

The Commonwealth Scientific and Industı
Research Organization invites applications for
pointment as Research Officer in the Organı
tion's Division of Plant Industry Locatio
Plant and Soils Laboratory, Brisbane, Quee
land Duties To undertake studies on
factors limiting legume establishment in sı
tropical areas and southern Queensland Qual
cations University honours degree in science w
botany and chemistry as major subjects or
agricultural science or equivalent qualificatio
Applications from persons finishing postgradu
work this year will be considered Salary
pendent on qualifications and experience c
mencing salary will be determined within
range of Research Officer, £A 1 058 to £A 1,
per annum actual, thirteen increments subject
efficiency review at £A 908 and £A 1,064
annum nominal Note The above salaries ap
to a male appointee , actual salaries include c
of living adjustment which at present increa
male nominal salaries by £A 198 per annum
appointment will be conditional on a satisfact
medical examination and the successful applic
will be eligible to contribute to, and receive be
fits from either the Commonwealth Superann
tion Fund or the Commonwealth Provident Fu
Fares to Australia (including those of wife
family) will be paid

Applications, referring to Appointment N
146/34, and stating full name, place, date
year of birth, marital state, nationality, pres
employment, particulars of qualifications and
perience, and of war service, if any, accompan
by copies of not more than four testimonials
the names and addresses of at least two pers
willing to act as referees, if so required, sho
reach the undersigned by February 5 1955

W IVES
Chief Scientific Liaison Offic
Australian Scientific Liaison Office
Africa House
Kingsway London

COMMONWEALTH of AUSTRALI
DEPARTMENT OF SUPPLY
HIGH SPEED AERODYNAMICS DIVISIO
AERONAUTICAL RESEARCH
LABORATORIES
SALISBURY, SOUTH AUSTRALIA

Applications are invited for a position of Sci
tific Officer, Grade 1 in the Instrumentation S
tion of the above laboratories Salary £A
to £A 1,106 per annum Duties Developm
and design of general physical and particula
optical instruments for aerodynamics resear
Qualifications University degree of high stand
in physics or equivalent qualifications and pref
ably some experience in optical instrumentat
Where permanent appointment is accepted,
successful applicant will be eligible to becom
contributor to the Commonwealth Superannuat
Scheme Under specified conditions first-c
boat fare (if first-class berth available) of
appointee and his dependants (wife and depend
children) will be paid by the Commonwea
Salisbury is situated 16 miles from Adelaide,
capital of South Australia

Application forms obtainable from the Ser
Representative (A P 23), Department of Sup
Australia House, Strand, London, W C 2,
whom applications should be lodged by Janu
20 1955

COLONIAL PRODUCTS LABORATO
Imperial Institute Building, London S W 7,
quires Scientific Officer or Assistant Experimen
Officer to assist in laboratory investigations So
knowledge of and experience in essential o
perfumery materials, gums, resins or spices de
able Qualifications Scientific Officer B
with first- or second-class honours in chemi
(organic) or equivalent qualifications Assist
Experimental Officer, higher school certific
with science subject as principal subject, or e
valent qualification , or general certificate
education in five subjects with two scientific s
jects at advanced level Salaries Men Sci
tific Officer, £470 to £855 (£605 on confirmat
of appointment at age 24 or over) Entry p
determined by qualifications and experien
F S S U Superannuation Assistant Exp
mental Officer, £290 (at 18) to £645 (highest p
of entry into scale £520) Women somew
less Additional pay supplement varying fr
£12 10s under 21 to £30 for salaries over £
and up to £900 —Application forms from Mini
of Labour and National Service, Technical
Scientific Register (K), Almack House, 26 K
Street London S W 1 quoting F 904/54A C
ing date January 29 1955

UNIVERSITY OF THE WITWATERSRAND

OHANNESBURG SOUTH AFRICA

IBER OF MINES—CHAIR OF MINING ENGINEERING

lications are invited for appointment to the of Professor in Mining Engineering who Head of the Department of Mining The itive salary attached to the post will be inged between the successful applicant and iversity, but will not be less than £3 000 num In addition a married man will re- a cost of living allowance at such rate as e authorized from time to time, the present eing £234 per annum Membership of the sity Institutions' Provident Fund is com- and involves a contribution of 7 per cent pensionable salary, the Government and niversity together contributing an equal t The pensionable salary is at present per annum Membership of the univer- staff medical aid fund is also compulsory case of an officer who is eligible for such rship, and contributions will be in accord- vith the rules of the fund The Professor called upon as part of his duties to serve onsultant to the Transvaal and Orange Free Chamber of Mines He will not, except special circumstances be granted permis- o engage in private consultative work are to be assumed on July 1 1955 or as s possible thereafter

her particulars and information as to the l of application may be obtained from the ry, Association of Universities of the Commonwealth 5 Gordon Square, n W C 1 The closing date for the re- of applications in South Africa and n is January 31, 1955

CHELSEA POLYTECHNIC

MANRESA ROAD S W 3

D OF DEPARTMENT OF GEOLOGY

Governors invite applications for the post ad of the Department of Geology which es vacant through the retirement of Dr Fleet Candidates should possess high ations in geology, and have had experi- in both teaching and research Salary Grade II (men £1 065 by £25 to £1,215, £852 by £20 to £972) plus London allow- f £36 or £48, according to age Duties nmence September 1 1955

her particulars and form of application may ained by sending stamped addressed fools- velope to the undersigned to whom appli- must be returned not later than February 55

M H LIGHTFOOT M A, F R S E,
Principal

TRAL RESEARCH ESTABLISHMENT al Coal Board (at Isleworth, Middlesex) is concerned with mining problems, invite tions for a superannuable appointment of icist to lead a group carrying out research erground transport of coal The work will cerned initially with belt conveyors and s measurements of stress set up in the ies under working loads and the study of t physical properties of belt materials which ine their optimum performance and long Candidates should have a good honours in physics or equivalent professional quali- s proved research ability and preferably nce in strain measurements and/or mech- properties of materials Appointment will Scientist I (scale £1 150 by £40 to £1 350, d by a range to £1,550 male) London loca- lowance of £82 at the minimum rising to t the maximum is payable in addition — giving full particulars (in chronological of age education qualifications and ex- e (with dates) to National Coal Board shments (Personnel) Hobart House Gros- Place London S W 1 marking envelope) Original testimonials should not be ded Closing date January 15 1955

AL VETERINARY COLLEGE AND al (University of London) Applications ited for a Lectureship in Animal Nutrition Department of Veterinary Hygiene and Ani- usbandry The person appointed will be d to undertake teaching and research in ochemistry of this subject The present scale which is in course of being revised) by £50 to £900 £900 by £50 to £1 150 num Initial placing according to quali- s and experience Superannuation benefits hildren s allowances —Application forms able from the Secretary should reach him ter than January 31 1955, at the Royal nary College Royal College Street, London, l

---

KUMASI COLLEGE OF TECHNOLOGY

(Principal W E Duncanson, Ph D D Sc, F Inst P)

Applications are invited for appointment as (1) Senior Lecturer in Physics (2) Lecturer in Mathematics Salary scales, Senior Lecturer £1 400 to £1,850 per annum Lecturer £880 to £1 560 per annum Initial salary according to experience Posts are pensionable but temporary appointments carrying gratuities and 10 per cent higher salaries might be made Partly furnished houses provided rent according to salary Free first-class passages to and from Gold Coast for persons appointed wives and up to three children under 13 Generous home leave, normally annual on full salary

Write for further information to Secretary Advisory Committee on Colonial Colleges 1 Gordon Square, London W C 1 Closing date for applications (six copies) February 7 1955

THE UNITED KINGDOM ATOMIC Energy Authority Aldermaston Berks requires a Physicist with metallurgical experience or Metallurgist with a good physical background in the grade of Senior Scientific Officer for research into the plasticity of novel alloys This work is of a fundamental nature, but the emphasis will be on those aspects of the topic relevant to the technological processes of forging and rolling Within the confines of a general supervision the successful applicant will have a good deal of freedom to choose the pattern of his work in this field Applicants should possess a first- or second-class honours degree in physics or metallurgy, and should have had some years appropriate postgraduate research experience The scale of pay is £970 to £1 125 (male) per annum The successful candidate will be required to join the Authority s Principal Superannuation Scheme to be introduced shortly and the salary scale quoted above will be enhanced to cover contributions Housing accommodation will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities —Application form from Senior Recruitment Officer, Atomic Weapons Research Establishment Aldermaston, Berks Quote Ref 135/W G E/34

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston Berks requires a Senior Experimental Officer to advise technical and scientific staff on safe working in laboratories pilot plant, and production units associated with a wide range of chemical and physical research problems The successful applicant will act as deputy to the Establishment Safety Officer Minimum qualification is higher school certificate but a pass degree in chemistry and previous experience of the control of staff and of work on explosives is desirable The scale of pay (minimum age 35) is £1 017 to £1 197 per annum The successful applicant will be required to join the Authority's Principal Superannuation Scheme to be introduced shortly, and the salary scale quoted above will be enhanced to cover contributions Housing accommodation will be available within a reasonable period for married staff who live outside the Establishment's transport facilities —Application form from Senior Recruitment Officer A W R E Aldermaston Berks Quote ref 336/W G E/34

SCOTTISH HOME DEPARTMENT BROWN Trout Research Laboratory Pitlochry Scientific Officer Applications are invited for a post unpensionable in the first place of Scientific Officer (Chemist) Candidates should normally be 21 and under 28 years of age on December 31 1955 They should possess a first- or second-class honours degree in chemistry or in a biological subject with chemistry as an additional subject, or an equivalent qualification Successful candidate will be a member of a small team investigating chemical problems of freshwaters and working in close association with biologists He will be particularly associated with consultative work on pollution problems Inclusive salary £467 to £845 (men) £467 to £750 (women) —Particulars and application form from the Establishment Officer Scottish Home Department, Room 364 St Andrew s House Edinburgh 1 Completed applications to be returned by January 31 1955

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

invites

MATHEMATICIANS AND THEORETICAL PHYSICISTS

to join the Atomic Weapons Research Establishment to investigate a range of problems in classical and nuclear physics

Those interested should apply in the first instance to Mr W R J Cook Deputy Director A W R E Aldermaston Berkshire giving details of their academic training and research experience The posts are pensionable Salary will be in the range of £1,700 to £2 200 per annum Houses on a rental basis will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities

●

H M OVERSEA CIVIL SERVICE

Vacancies exist for Chemists in the Government Chemist Departments of (a) Tanganyika (BCD 97/8/01) and (b) Federation of Malaya (BCD 97/60/01) Qualifications (a) Honours degree in Chemistry or Associateship of Royal Institute of Chemistry Age limits 20 to 30 years (b) Honours degree in chemistry with Associateship or Fellowship of Royal Institute of Chemistry Two years' specialized experience in some line (forensic science toxicology foods drugs and water, bacteriology pharmacy, etc), relevant to the work in Malaya, or research experience indicated by Ph D or comparable postgraduate qualification Age limits 25 to 27 years Duties (a) General analytical and research work in toxicology, food drugs industrial chemistry Supervision of African Chemical staff (b) General analytical and consultative work on liquors, foods drugs, water, and petroleum, etc Clinical analysis and examination of exhibits for Court evidence Inspection of petroleum carrying vessels and explosives Terms of Appointment (a) Pensionable emoluments in the scale £816 to £1 620 plus cost of living allowance at present 10 per cent (b) Pensionable with salary in scale £738 to £1 680 per annum In addition an overseas allowance of between £266 to £623 per annum (together with a cost of living allowance) both according to family commitment is also payable

Apply in writing to the Director of Recruitment Colonial Office Great Smith Street London, S W 1, giving briefly age qualifications and experience Mention the reference number shown against the post applied for

---

FEDERATION OF RHODESIA AND NYASALAND

MALE MEDICAL ENTOMOLOGIST

MINISTRY OF HEALTH

Applicants under 35, must be British subjects or citizens of Eire holding an honours degree (or higher academic qualification) with entomology or zoology as major subjects Duties include entomological research and control, both in the field and at the Research Laboratory Salisbury, malaria control and identification of insects, training of junior members of laboratory staff and training and organization of the work of African mosquito collectors Commencing salary £800 to £1 100 per annum according to qualifications and experience, on scale rising to £1 800 per annum

Application forms and further details from the Secretary Rhodesia House, 429 Strand, London W C 2, closing date January 31 1955

UNIVERSITY OF BIRMINGHAM

LECTURESHIP IN PHYSICS

Applications are invited for a Lectureship (Grade II) in the Department of Physics The person appointed will be expected to take a full part in the research work of the Department which lies mainly in the field of experimental nuclear physics The initial salary will not be less than £650 per annum, nor more than £1 300 per annum and the post will carry superannuation and where applicable family allowance benefits

Applications including the names of two referees should reach the Registrar The University Birmingham, 15, by February 15 1955

● G L BARNES
Secretary

The University
Edgbaston 15 ●

SENIOR TECHNICIAN REQUIRED FOR Zoology Department, University of London scale of wages including London weighting —Apply Secretary Royal Holloway College Englefield Green Surrey

FOURAH BAY COLLEGE

SIERRA LEONE

(University of Durham)

Applications are invited for the following posts (1) Senior Lecturer in Engineering, to be in charge full-time course in Engineering Technology which will cover training for civil, electrical and mechanical engineers to approximately ordinary national diploma level and is designed as first stage towards full professional training Candidates should be graduates and corporate members of major engineering institution, preferably civil or mechanical, (2) Lecturer in Physics, and (3) Lecturer in Botany, to be responsible, under the tutor in charge of science studies, for organization and supervision of courses At present physics and biology are taken to general certificate of education (advanced) level but physics and botany may soon be introduced into a university course leading initially to first examination for general B Sc (Durham) Candidates should have good honours degrees university teaching experience desirable The College reconstituted in 1950, retains the Christian traditions of its foundation by the C M S 126 years ago Posts are permanent and pensionable but temporary appointments could be made Salary scales (gross) Senior Lecturer, £1,370 to £1,800 per annum, Lecturers, £790 to £1,500 per annum Point of entry according to qualifications and experience Generous home leave, normally annual, on full pay Free first-class passages, one each way for each tour of service, for persons appointed, wives and up to three children under 10 (or an allowance of £50 per annum for up to three children under 16) Furnished houses at low rental

Write for further information to Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W C 1 Closing cate for applications (6 copies) February 7, 1955

CORYNDON MUSEUM

Applications are invited for the post of Entomologist at the Coryndon Memorial Museum, Nairobi The salary scale is £655 by £35 to £1 075 The post carries home leave privileges on full pay with return passage For further details apply to the Curator

Applications, with covering references must be received by February 15, 1955, and an indication given of when the applicant can take up the appointment Indications should also be given of any group of insects in which the applicant has specialized A good knowledge of Lepidoptera is desirable

---

NATIONAL COAL BOARD INVITE APPLICATIONS for a superannuable appointment from graduates in mathematics, mining engineering, chemistry or physics, or from men with equivalent qualifications, for a post in South Wales in the Pneumoconiosis Field Research (a long-term investigation into the incidence of pneumoconiosis among mineworkers) The appointment, according to qualifications and experience, will be as Scientist Grade II (scale £800 by £35 to £1,150) or Scientist Grade III (scale £500 by £25 to £950) The successful candidate, after training, will undertake environmental studies at Fernhill and Ffalden collieries, where the duties involve shift-work and spending up to three days a week underground, investigating and measuring environmental conditions, especially dust concentrations The remaining time will be occupied in evaluating samples in the laboratory Previous underground experience is not essential, but ability to supervise junior staff is required —Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to National Coal Board Establishments (Personnel) Hobart House, Grosvenor Place, London S W 1, marking envelope TT/901 Original testimonials should not be forwarded Closing date January 24, 1955

PHYSICAL CHEMIST OR CHEMICAL ENgineer required by Ministry of Supply Rocket Propulsion Department, Royal Aircraft Establishment Westcott, Bucks, to conduct experimental work in connection with fire prevention and extinction in aircraft Qualifications Higher school certificate (science) or equivalent, but a pass degree or H N C in chemistry or a diploma or similar qualification in chemical engineering, may be an advantage Some knowledge of properties of fuels and combustion useful Appointment in grade of Experimental Officer (minimum age 26) within salary range £690 to £850 per annum Women somewhat less Pay supplement of from £25 to £30 per annum also payable —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K), Almack House, 26 King Street, London, S W 1 quoting F 925/54A Closing date January 29, 1955

PUBLIC SERVICE OF THE TERRITORY OF PAPUA AND NEW GUINEA

Agronomist, Grade III £A 1,442 to £A 1,532 per annum Qualifications Degree in agriculture or equivalent, also experience agronomic research, wide experience in commercial rubber planting Salary shown is actual Additional £A 100 per annum is paid to married officers

Further details obtainable from the Official Secretary, Australia House, The Strand, London, W C 2 Applications close January 31, 1955

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston, Berks, requires Experimental Officers to assist technical and scientific advisers with the surveillance of all aspects of safe working in laboratories, pilot plant and small production units associated with general chemical and physical research problems and advising on the implementation of standard codes of practice, and the development of new ones as necessary Minimum qualification is higher school certificate, but a pass degree in chemistry is desirable Previous experience of the control of staff and for one post some experience of work on explosives would be an advantage The scale of pay is (minimum age 26) £715 to £880 (male) per annum The successful applicants will be required to join the Authority's Principal Superannuation Scheme to be introduced shortly, and the salary scale quoted above will be enhanced to cover contributions Housing accommodation will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities — Application form from Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks Quote Ref 337/W G E /34

DEPARTMENT OF SCIENTIFIC AND INdustrial Research have vacancies for four Assistant Experimental Officers (unestablished) at the Building Research Station, Garston, Herts, as follows Two Inorganic Chemists (Ref F 899/54A), one Physicist (Ref A 369/54A) and one Civil Engineer (Ref E 768/54A) Age at least 18 with G C E at advanced level in scientific subjects (or equivalent qualification), if over 22 candidates will generally be expected to have a pass degree, H N C, or equivalent Inclusive annual remuneration for 45½-hour week £297 to £659 (men), £297 to £530 (women) Prospect of pensionable posts for candidates under 28 — Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London S W 1 quoting appropriate reference Closing date January 22, 1955

LONDON TRANSPORT INVITE APPLICAtions from graduates, first- or second-class honours degrees in physics, for post in Central Laboratory, Chiswick Duties physical testing and investigation of wide range of items, including accumulators, electric lamps, plastics, rubber paper, insulating materials safety glass, etc, construction, maintenance and calibration of apparatus, development of non-destructive tests based upon ultrasonic, magnetic and electrical techniques, investigations of physical problems arising within London Transport Salary £520 to £800 (men) Commencing salary according to age, qualifications and experience Medical exam Contributory superannuation scheme after probation —Applications to Staff Officer (F/EV 502), London Transport 55 Broadway, S W 1 For acknowledgment enclose addressed envelope

---

A RESEARCH FELLOWSHIP OF £750 PER annum, renewable annually for a period of three years and tenable at the Chemical Research Laboratory of the Department of Scientific and Industrial Research Teddington is offered by the Forestal Land, Timber & Railways Co Ltd The research will be directed to investigating the function of tannins in preventing corrosion of metals, and the results could be made available for a higher degree Applicants should have as a minimum qualification a good honours degree in chemistry and preferably some research experience They should have a particular interest in applying fundamental physical chemistry and physical methods of organic chemistry to problems of industrial importance —Applications, with references should be sent to the Chief Research Chemist, Forestal Central Laboratory, Harpenden Herts

---

UNITED KINGDOM ATOM
ENERGY AUTHORITY

A E R E, HARWELL, BERKS

Requires Chemists to develop and
methods of analysing biological and
materials for very low levels of radio
Candidates should possess minimum qualif
of higher national certificate in chemistry c
valent qualifications Appointments, ac
to age, experience and qualifications, will b
either in the grade of Experimental Office
mum age 26) (£715 to £880 per annum) o
tant Experimental Officer (£288 (at age 18)
per annum) Practical experience of a
work is essential for Experimental Offi
pointment, and is desirable for Assistant
mental Officer appointment A knowl
radiochemistry would be an advantage

Applications to Establishments Officer,
Kingdom Atomic Energy Authority, A
Harwell, Didcot Berks, quoting 2/103/21

UNIVERSITY OF BIRMINGH

RESEARCH FELLOWSHIP IN PHY

Applications are invited for a Research
ship tenable in the Department of Physics
value of about £500 per annum, with
benefit and, where applicable, family all
Preference will be given to a candida
desires to study the interactions with m
the radiations provided by the Depa
cyclotron and/or proton synchrotron, wit
ence either to biological or to physical
The Fellowship would be awarded for o
in the first instance, with the possib
renewal

Applications, including the names
referees, should reach the Registrar, The
sity, Birmingham, 15, by February 15, 1
G L BAR
Se

The University,
Edgbaston, 15

INTERNATIONAL UNION
CRYSTALLOGRAPHY

COMMISSION ON STRUCTURE REP

Applications are invited for the post of
tant Editor (man or woman) of Structure R
Qualifications Knowledge of chemistry an
cularly chemical nomenclature, reading kn
of principal European languages, interest i
ing University degree and knowledge of
or mineralogy desirable Salary in the
£500 by £50 to £650 The appointment
for one year, and may be renewed for
periods of one year Place of work,
Duties to commence as soon as possible a
later than October 1, 1955

Applications (three copies) should be ad
to Professor A J C Wilson, Departm
Physics, University College, Cardiff, Great
from whom further information may be ob

DEPARTMENT OF SCIENTIFIC AN
dustrial Research require an Assistant
mental Officer (unestablished) at the Britis
monwealth Geological Liaison Office, Ki
W C 2, for the extraction, collation and re
of information on mineral resources an
logical happenings from technical libraries
didates must have G C E advanced level
science subjects, including geology or equ
Over 22, a pass degree in geology or equ
will generally be expected Experience
required type of work would be an adv
but is not essential Inclusive annual rem
tion for a 45½-hour week within the rang
(at age 18) to £690 (men), £311 (at age
£587 (women) —Application forms from M
of Labour and National Service, Technica
Scientific Register (K), 26 King Street, L
S W 1, quoting G 378/54A

MINISTRY OF SUPPLY REQUIRES
perimental Officers for appointment as A
Resident Technical Officers (Engines) at
contractor's works in Derby, Coventry and
Responsible to the Resident Technical Offi
technical matters concerning design testin
modification of aero engines Qualific
Higher school certificate (science) or equi
but possession of a degree or H N C in en
ing may be an advantage Workshop and
ing office experience required and engi
apprenticeship desirable Salary Within
mental Officer range (minimum age 26) £
£850 per annum (Derby), £705 to £870 per
(Coventry and Bristol) Women somewha
Pay supplement of from £25 to £30 per
also payable —Application forms from M
of Labour and National Service, Technica
Scientific Register (K) 26 King Street, L
S W 1, quoting C 886/54A

SOUTH SHIELDS DISTRICT HOSPITAL MANAGEMENT COMMITTEE

pplications are invited from science graduates the appointment of Biochemist (non-medical) ell equipped and modern Group Laboratory, eral Hospital South Shields Salary either basic grade or senior grade of Professional Technical Whitley Council scale according ualifications and experience viz basic grade to £510, and after probationary period £585 765, senior grade £835 to £1,080 Post s facilities for further studies

pplications accompanied by names of two ees to Group Secretary, Ingham Infirmary, h Shields within ten days

---

WYE COLLEGE

DEPARTMENT OF HOP RESEARCH (UNIVERSITY OF LONDON)

e Governing Body of the College invites ap- tions for the post of Plant Pathologist in College Hop Research Department Appli- s should be graduates in pure or applied ny and should be competent to undertake rch work with special reference to disease ance and to chemical and cultural controls rience of agricultural research work under conditions is desirable The appointment be made in the Scientific Officer grade (be- n £467 and £848), according to qualifications experience

rther particulars may be obtained from the strar, Wye College Wye, Kent

---

UNIVERSITY OF LEEDS

DEPARTMENT OF BOTANY

pplications are invited from candidates with al interests in genetics or genecology, for ap- tment as Lecturer or Assistant Lecturer in ny the salary scales are at present under w

pplications (three copies) stating date of birth, fications and experience, together with the s of three referees should reach the Regis The University, Leeds 2 (from whom further culars may be obtained) not later than uary 19 1955

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG SOUTH AFRICA

plications are invited for appointment to acant post of Lecturer in Chemistry Special fications in inorganic and analytical chemis- vill be a recommendation The substantive y scale attached to the vacant post is £850 50 to £1 150 The initial salary to be paid e successful applicant will be determined cordance with qualifications and experience dition, a temporary cost-of-living allowance yable to married men, the present rate being per annum An allowance is made towards ost of travelling expenses Duties to be ed March 1 1955 or as soon as possible after

rther particulars and information as to the od of application may be obtained from the tary Association of Universities of the h Commonwealth, 5 Gordon Square, Lon- W C 1 The closing date for the receipt plications in South Africa and London, is ry 31 1955

UTH-EASTERN GAS BOARD, CENTRAL ratories 709 Old Kent Road London, 5 Vacancies exist for Junior Assistant ists Applicants should possess a B Sc e or its equivalent, some experience in fuel ology, though not essential would be of ntage Salary £530 to £640 per annum ding on qualifications and experience rian (female) Applicants for this post d possess a science degree and a good ing knowledge of French and German so be capable of freely translating original tific papers in these languages Salary £424 512 per annum —Applications in writing full details to Personnel Manager arine Street, Croydon, quoting reference 488

PLICATIONS ARE INVITED FROM en holding degree in biology for appointment aematological Technician Previous experi- in haematology not necessary In first in- e appointment will be made in grade of ician (£450 to £515 per annum) Promotion e grade of Senior Technician (£540 to £625 nnum) will be made if satisfactory after pro- nary period of one year Salary and condi- according to Whitley Council —Apply Dr , Royal Berkshire Hospital, Reading

---

UNIVERSITY OF CAMBRIDGE

DEPARTMENT OF CHEMICAL ENGINEERING

The Appointments Committee of the Department of Chemical Engineering hope soon to be in a position to appoint one University Lecturer and two University Demonstrators in Chemical Engineering Applications will be considered from persons of broad scientific education experienced in some branch of chemical engineering physical chemistry, physics, or mechanical engineering The appointments will be subject to the Statutes and Ordinances of the University

Further particulars and forms of application may be obtained from the Secretary of the Appointments Committee of the Department of Chemical Engineering, Tennis Court Road, Cambridge, to whom applications should be sent so as to reach him by March 11, 1955

ROWETT RESEARCH INSTITUTE

Scientific Officer required to undertake research on nutrition of sheep Candidates should possess a first- or good second-class honours degree in agriculture physiology or zoology, or equivalent qualification Practical knowledge of sheep husbandry is not essential Salary scale £445 to £815 with initial placing according to experience Superannuation under F S S U

Applications, stating date of birth and particulars of qualifications and experience, together with the names of three referees, should be addressed to the Secretary Rowett Research Institute, Bucksburn, Aberdeenshire

---

BATTERSEA POLYTECHNIC

LONDON S W 11

Applications are invited from honours graduates of a British university with postgraduate experience in organic chemistry, for the post of Grade B Lecturer Salary £621 or £633 by £25 to £928, plus £30 for a good honours degree with an allowance of £18 for three years' £36 for four years and £54 for five years training and increments for industrial and research experience, less statutory deductions

Further particulars from the Clerk to the Governing Body, by whom applications should be received on or before January 28, 1955

PSYCHOLOGISTS IN THE CIVIL SERVICE The Civil Service Commissioners invite applications for nine permanent posts for Psychologists at Industrial Rehabilitation Units under the Ministry of Labour and National Service and for one temporary post for a Senior Psychologist (with permanent appointment as Psychologist) Age for the Psychologist posts at least 21 and under 31 on June 1, 1954 with extension for Regular Forces' service for the Senior Psychologist post at least 27 on June 1 1954 All candidates must possess one of the following qualifications (a) A first- or second-class honours degree of a recognized university in which psychology was taken as a main subject (b) A higher degree in psychology (c) A Bachelor of Education degree of a Scottish university or of the University of Belfast (d) A postgraduate diploma in psychology following at least two years' systematic study (e) Fellowship of the British Psychological Society (f) Associateship of the British Psychological Society (subject to certain conditions) Candidates who expect to obtain one of these qualifications shortly after the date for the submission of applications may be considered Exceptionally a candidate may be accepted if he has at least three years' responsible professional experience London remuneration (including extra duty allowance where payable) Senior Psychologist £993 to £1 328 (men) £880 to £1 161 (women) Psychologist £510 (at age 21) to £1 117 (men) £994 (women) Starting pay up to £874 (men) £847 (women) at age 30 or over on entry Promotion prospects —Particulars and application forms from Secretary Civil Service Commission Burlington Gardens, London W 1, quoting No 118/54 Application forms to be returned by February 3 1955

AIR MINISTRY REQUIRES SCIENTIFIC Officer (male) at R A F Station near High Wycombe Bucks for operational research duties theoretical studies and development work in field of communications and general electronics Qualifications First- or second-class honours degree in physics or electrical engineering or equivalent Salary Within range £467 10s to £845 Post unestablished with possibilities of establishment through Civil Service Commission whilst remaining under age 31 Opportunities for promotion to higher grade posts on staff of Scientific Adviser to Air Ministry —Application forms quoting A 109/54A from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street London S W 1

UNIVERSITY OF CAMBRIDGE

FACULTY OF ENGINEERING

Applications are invited for four posts of University Lecturer or University Demonstrator, for one post of Assistant Director of Research and for two posts of Senior Assistant in Research The persons appointed to the lectureships or demonstratorships will be expected to have engineering experience they will be required to teach primarily in either the field of servo-mechanisms of the utilization of nuclear energy or of the strength of materials with particular reference to soil mechanics The persons appointed to the research posts will be required to work either in the field of servo-mechanisms or in that of framed structures Persons appointed will be required to take up their duties as early as possible The appointments will be subject to the Statutes and Ordinances of the University

Details of the regulations and stipends for the posts will be sent on application, inquiries should be addressed to the Secretary of the Appointments Committee, Engineering Laboratory, Trumpington Street Cambridge, and should reach him by January 21, 1955

UNIVERSITY OF LEEDS

DEPARTMENT OF COAL GAS AND FUEL INDUSTRIES WITH METALLURGY AND CHEMICAL ENGINEERING

The Council invites applications for four posts in the Department in chemical engineering, in gas engineering and in fuel technology Appointments will be made on the Lecturer scale and on the Assistant Lecturer scale (both at present under review)

Applications (three copies), stating date of birth qualifications and experience together with the names of three referees should reach the Registrar The University, Leeds 2 (from whom further particulars may be obtained) not later than January 17, 1955

UNIVERSITY OF ABERDEEN

Senior Technician required for Physiology Department, Marischal College Wage on scale £460 by £20 to £560 placing according to qualifications and experience

Applications in writing to the Secretary Marischal College

TEA RESEARCH INSTITUTE OF CEYLON

Post of Director

Applicants are advised that the closing date for the above post has been extended to January 31 1955

UNIVERSITY COLLEGE LONDON (Gower Street W C 1) requires Technician for Department of Phonetics preferably interested in acoustics, to assist in construction of electronic equipment Good holidays and pension scheme

Application forms from Secretary, quoting Phonetics/3

AGRICULTURAL RESEARCH COUNCIL require a Senior Experimental Officer in the Biochemistry Department of their Institute of Animal Physiology Salary scale £1 017 to £1,197 Superannuation under F S S U Degree or equivalent qualification and laboratory administrative experience essential, age not below 35 —Applications with names of two referees to Secretary Institute of Animal Physiology Babraham Cambs not later than January 31 1955

ELECTRONIC ENGINEER REQUIRED AT Ministry of Supply, Headquarters, London to work in branch of guided weapons directorate responsible for planning and progressing contracts with various weapons firms The officer will be required to visit these contractors during the course of his duties Qualifications Higher school certificate (science) or equivalent, but possession of degree or H N C in electrical engineering may be an advantage Knowledge of electronics required and some experience in guided weapons field would be an asset Salary within Experimental Officer range (minimum age 26) £720 to £890 per annum (women somewhat less) plus pay supplement of £30 per annum —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K), 26 King Street London S W 1 quoting D 650/54A

MEDICAL RESEARCH COUNCIL REQUIRE Technician for maintenance of apparatus gas analysis etc at poliomyelitis unit at National Hospital W C 1 S T A Diploma an advantage Salary according to age and experience —Write (two referees) to Dr G Pugh, M R C Laboratories Holly Hill Hampstead N W 3

CENTRAL RESEARCH ESTABLISHMENT, National Coal Board (at Isleworth, Middlesex), which is concerned with mining problems, invite applications for the superannuable appointment of an Engineer to carry out research on instrumentation The work will be concerned with the design and development of mechanical and electromechanical instruments required for mining research both in the laboratory and underground Candidates should have good honours degrees in mechanical engineering and preferably some experience in research or instrumentation practice Appointment will be according to qualifications and experience as either Scientist II (scale £858 to £1,232 inclusive male and £750 to £1,070 inclusive female) or Scientist III (scale £534 to £1 016 inclusive male and £509 to £893 inclusive female) —Write, giving full particulars (in chronological order) of age education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1 marking envelope TT/902 Original testimonials should not be forwarded Closing date January 29, 1955

MINISTRY OF AGRICULTURE AND Fisheries require Scientific Officer at Tolworth Surrey, for general chemical and analytical work connected with chemical methods for the control of various animal pests and insects on stored products Qualifications Degree in chemistry or equivalent Salary according to experience, on scale £492 10s to £885 Appointment may last not more than approximately twelve months —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K) Almack House 26 King Street London, S W 1 quoting F 679/54A Closing date January 29, 1955

APPOINTMENTS VACANT

RECENTLY QUALIFIED CHEMIST, B Sc, or A R I C age 20 to 24, required as Assistant to Head of Research and Development Department The work involves both organic and inorganic syntheses up to and including pilot plant Five-day week, canteen facilities —Write to Works Director, Thomas Morson and Son, Ltd, Wharf Road, Ponders End Middlesex

MEDICAL REPRESENTATIVES BRITISH subsidiary of leading American ethical pharmaceutical house have vacancies in several areas for Medical Representatives Good starting salary and expenses Car provided —Applications, with full particulars of age, qualifications, experience and salary required in writing only, to the Manager Pfizer, Ltd, 137-139 Sandgate Road, Folkestone, Kent

ENGINEER WANTED BY IMPERIAL CHEMical Industries, Ltd, Alkali Division, Northwich, Cheshire, to do research on industrial chemical operations such as heat transfer and matter transfer Candidates, aged 25 to 35, should possess an honours degree in engineering (preferably mechanical) and have received such practical training as is required for Associate Membership of the major Engineering Institutions Starting salary according to age and experience —Applications giving details of age and experience, should be addressed to the Staff Manager

YOUNG MAN HAVING A NATIONAL certificate or equivalent in physics or electrical engineering is required for a post in the measurement section of a development laboratory in Northamptonshire The work is connected with microwave equipment, but experience in this field is not essential Salary will be in accordance with age, etc —Box 608, T G Scott and Son Ltd 143-147 Regent Street London W 1

BRITISH CHROME AND CHEMICALS LTD require two physical chemistry graduates with research experience, preferably in industry capable of leading small teams with energy and persistence One team to investigate phase relationships in systems at elevated temperatures, the other to deal with problems of a general nature in electrochemistry and surface chemistry and with the development of physico-chemical methods of analysis Salaries will be according to experience and qualifications, and the successful applicants will be eligible for membership of an approved pension scheme after twelve months' service —Applications, which will be regarded as confidential, giving the fullest details of experience and qualifications as concisely as possible should be addressed to W H Morrow, Technical Director, British Chrome and Chemicals Ltd, Urlay Nook Eaglescliffe Stockton-on-Tees

LADY CHEMIST, GRADUATE OR H N C required for analysis of electroplating and allied solutions —Apply Electro-Chemical Engineering Co Ltd 161 Queens Road, Weybridge, Surrey

TECHNICAL DEVELOPMENT

Opportunities exist for Graduates to enter an expanding and interesting field of work Appointments are to be made in both senior and intermediate capacity on the staff of a Development Group engaged on projects entailing a special knowledge of an interest in thermodynamics and physical chemistry Applications are invited from 1 Graduates, with a good science degree and at least four years' research or development experience, and being within the age group 27 to 35 Commencing salary from £1 000 per annum according to experience and ability 2 Graduates with a good science degree and within the age group 21 to 26 Previous experience is not essential, and graduates due to complete their National Service within the next twelve months are also invited to apply Commencing salary from £650 per annum

Applications should be addressed to Box 612, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1, and give fullest possible information of qualifications and experience

FISONS, LIMITED, REQUIRE TRANSlator proficient in technical German, financial and spoken French Spanish Italian Russian Dutch desirable but not essential Salary according to qualifications Pleasant conditions and pension scheme —Applications to Personnel Officer (L), Fisons, Limited, Harvest House, Felixstowe, Suffolk

DEXION, LIMITED OUR VERY rapid growth and solidly based success is due to a fresh approach to industry We have unusual ideas—one of them is that young men with good scientific or technical background and a thorough understanding of the scientific method could inject new vigour into the organizational and administrative side of industry If you are interested in this idea and feel you have something to contribute, there is scope and opportunity for you in our organization On our part we are prepared to pay well and give all the necessary encouragement, help and training —Write for further details to the Personnel Manager, Dexion Limited 65, Maygrove Road, Kilburn, London, N W 6

PILKINGTON BROTHERS, LIMITED, WHO are the largest manufacturers of plate and sheet glass in the British Commonwealth, and employ more than 20 000 persons, wish to appoint a Head of their Technical Development Department This is a new appointment necessitated by the large number of development projects in hand It is intended that the man selected should take charge of the development of new processes and the radical improvement of existing ones There are ample technical resources available, and the Company spends large amounts on development work Applicants must have a good honours degree in engineering, physics or chemistry They must also have a flair for development work, and the enthusiasm to see a job through Applications will be welcomed from men aged preferably 35 to 45, who have done at least five years' development work in industry or at a university The Company is prepared to offer a service agreement on an attractive salary to the right man The Company operates contributory superannuation and widows pension funds —All applications will be treated confidentially, and should be addressed to the Chief Personnel Officer, Pilkington Brothers, Limited, The Glass Works, St Helens, Lancashire

BOOTS PURE DRUG CO, LTD, REQUIRE a woman graduate in their Microbiology Division to carry out routine assays and investigations into assay techniques on antibiotics and vitamins Experience in this field of microbiology would be an advantage and salary will be according to experience and qualifications —Applications to the Personnel Manager, Station Street Nottingham

ASSISTANT WORKS CHEMIST, PREFERably a graduate with some experience, aged 25 to 30 for development and control of organic chemical processes Capable of working on own initiative with a minimum of supervision —Apply with full details of training and experience and salary required to Box 604, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

WOOL INDUSTRIES RESEAR ASSOCIATION

Physicists with honours degree require (1) Fundamental research on adhesion, f and abrasion (2) Weaving research Th involves experimental and analytical investi on looms and in the laboratory, it r mechanical aptitude and a liking for c physics Age 22 to 26 Previous research ence not essential Commencing salary ac to age and experience in range £530 to £8 annum for post (1), and £530 to £665 per for post (2), F S S U benefits

Applications to Wool Industries R Association, Torridon Headingley, Leeds,

THE ENGLISH ELECTRIC COMPAN vites applications for progressive posts Mathematical Physics Group of the Weapons Division, Luton The work co theoretical analysis relating to a wide ra engineering problems and the application tronic analogue and digital computers t solution Applicants should hold at le honours degree in mathematics, physics gineering, and should preferably have had years' experience in engineering research salary will be in accordance with qualifi and experience Assistance with hous commodation may be given —Applicati Dept C P S, 336-7 Strand, W C 2, quotin S A 50B

SMITHS AIRCRAFT INSTRUMENTS have vacancies in their Engine Controls I ment for Senior and Junior Graduate En and Physicists interested in research and d ment of automatic controls for aero gas tu Experience in, and knowledge of theoretica or practical aspects of servo mechanisms, o netic amplifier and electronic technique electro-mechanical equipment, together w appreciation of the requirements for a equipment, would be an advantage would be commensurate with qualification experience —Apply giving details and qu tions, quoting Reference 49/EN to The P nel Department Smiths Aircraft Instruments Bishop's Cleeve, near Cheltenham Glos

BACTERIOLOGIST, WITH UNIVER degree, wanted to take charge of laborator ducing veterinary sera and vaccines M experienced in laboratory techniques and had at least two years' practical expe Knowledge of veterinary work an advantag not essential —Box 619, T G Scott and Ltd 143-147 Regent Street London W 1

TEXTILE CAREERS BRITISH N Spinners, Limited, have several vacanci young graduates who will be given extensiv nological training, enabling them to b specialists in this expanding organization ideal qualification is a university degree i sics, engineering or textiles, and candidates have a natural bias towards applied work selected candidates will be put to work the supervision of experts and training w clude a thorough grounding in the manufa of yarns and fibres, and later in their d ment and processing to meet changing requirements Upon successful complet this training it is intended to employ these ates in responsible positions on either te development and experimental work or field of technical service There will a openings on the commercial side of the bu in which specialized knowledge can be appl the development of new end-uses for the pany's products A realistic salary will b during training, and these vacancies offer tional opportunities to men who are will work hard with a specific object and in a of technical stimulation and progress — should contain full details of academic a ments and a frank statement of ambitions a clinations, these should be addressed Personnel Manager British Nylon Sp Limited Pontypool, and will be treated wit confidence Candidates invited for intervie be given a very clear impression of all implied by this new type of career

LABORATORY ASSISTANT REQU for interesting and varied work in small de ment unit Experience not essential —Wr telephone Sucal Ltd, 1-3 Marban Place, Ladbroke 4774

GRADUATE CHEMIST METALLUR or Chemical Engineer required to deal with lems relating to the installation of electro plant and process control Applicants mus completed military service and be willing to —Apply Electro-Chemical Engineering Co, 161 Queens Road, Weybridge, Surrey

An old firm...Wood Brothers makes a new glass... Firmasil

FIRMASIL low expansion borosilicate glass-ware meets the exacting conditions of the modern laboratory; it is unaffected by acids (except hydrofluoric) and, for practical purposes, by alkalis; it will withstand rapid heating and cooling without breaking; it can be 'lampworked' easily and does not normally devitrify. A brochure describing the chemical and physical characteristics of FIRMASIL and listing the range available will gladly be sent on request.

WOOD BROTHERS

Firmasil Regd.

RESISTANT GLASSWARE

Wood Bros. Glass Co. Ltd.
Barnsley, Yorkshire

FLUORITE OBJECTIVES

×50 (1/7 in.) Oil immersion N.A. 0.95
×100 (1/12 in.) Oil immersion N.A. 1.30

These new computations of outstanding merit are designed to be used with the NON-DRYING OIL supplied by us.

Compensating eyepieces ×6 and ×8 are available and should be employed to exploit fully the capabilities of these fine lenses.

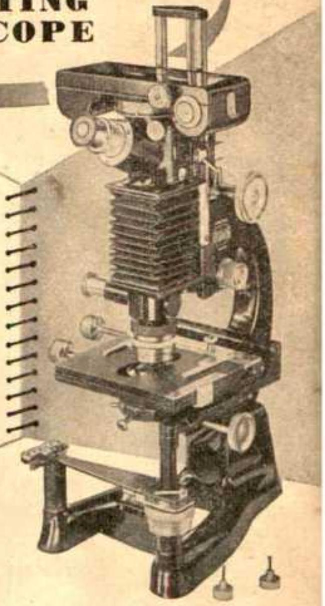
Each objective is tested on the BAKER OBJECTIVE-TESTING INTERFEROMETER and only the finest selected material is used in manufacture.

Further particulars on request

C. Baker
OF HOLBORN LTD. EST. 1765

METRON WORKS, PURLEY WAY
CROYDON, SURREY (CROydon 6644)
London Showrooms: 244 High Holborn, W.C.1

BECK
REFLECTING MICROSCOPE



for work in visible, ultra-violet and infra-red light, utilizing the range of reflecting objectives, with powers of X15 to X172

Full particulars from
R & J BECK LTD., 69/71 MORTIMER ST., LONDON, W.1.

The following outstanding instruments ar
now available . . .

1 NT. 11084

3 NT. 7569/P

2 NT. 11340

4 NT. 8834

1. MINIATURE pH METER — for on-the-spot determinations in the plant or in the field and for routine laboratory measurements.

2. SENSITIVE D.C. MICROVOLTMETER. This portable instrument provides the sensitivity of a freely suspended reflecting galvanometer in a robust, compact form. It also operates as a D.C. Amplifier with very low drift.

3. PORTABLE POTENTIOMETER—a robust compact instrument suitable for both workshop and laboratory use.

4. "SCALAMP" FLUXMETER provides exceptional performance; fitted with controlled return-to-zero device.

Please write now for your copy of the new catalogue 'J'.

Affiliated Companies:—
Pye (Canada) Ltd., 60 Front St. West, Toronto, Ontario, Canada
Electronic Industries Imports Pty. Ltd.,
139, Bouverie St., Carlton, N.3, Victoria, Australia.
Pye (N.Z.) Ltd., P.O. Box 2839, Auckland, New Zealand.

SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO. LTD · GRANTA WORKS · CAMBRIDGE · ENGLAN

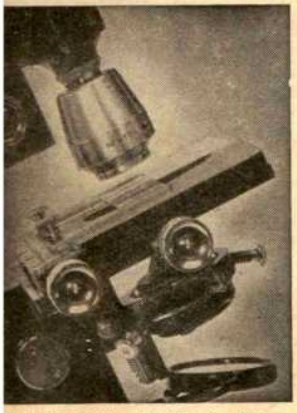
Printed in Great Britain by FISHER, KNIGHT & Co., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & Co., LIMITED, at St. Martin's Street, London, W.C.2, and ST. MARTIN'S PRESS, INC., 103 Park Avenue, New York 17, N.Y., U.S.A.—Saturday, January 8, 1955.

NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

INSTITUTE OF RADIO PHYSICS AND ELECTRONICS
LIBRARY
Dt. 28.2.55

Vol. 175, No. 4446 SATURDAY, JANUARY 15, 1955 Two Shillings



THE **Newton**

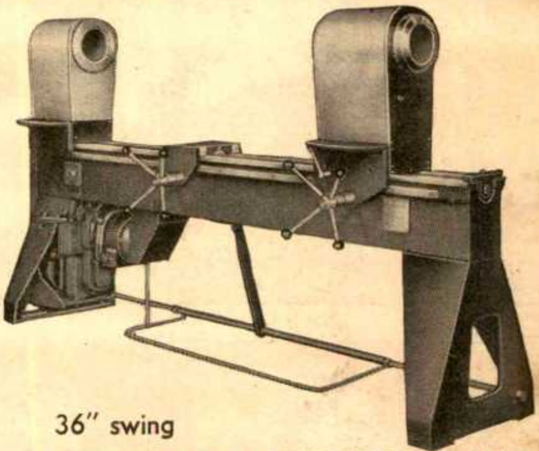
LONG WORKING DISTANCE ATTACHMENT

. . . provides a working distance of 12.8 mm. between object glass and specimen when fitted to a standard microscope in conjunction with a conventional 4 or 8 mm. objective.

A further important feature is that the use of this attachment eliminates image reversal and thus further facilitates examination and manipulation of specimens.

Write for further details to: Metropolitan-Vickers Electrical Co., Ltd.,
Trafford Park, Manchester, 17.
Member of the A.E.I. Group of Companies

N/A 101



HEAVY DUTY GLASS WORKING LATHE

36″ swing

HEATHWAY MACHINERY CO. LTD.
UXBRIDGE ROAD, HILLINGDON, MIDDX.

THE BAKER INTERFERENCE MICROSCOPE

is now being employed extensively for:

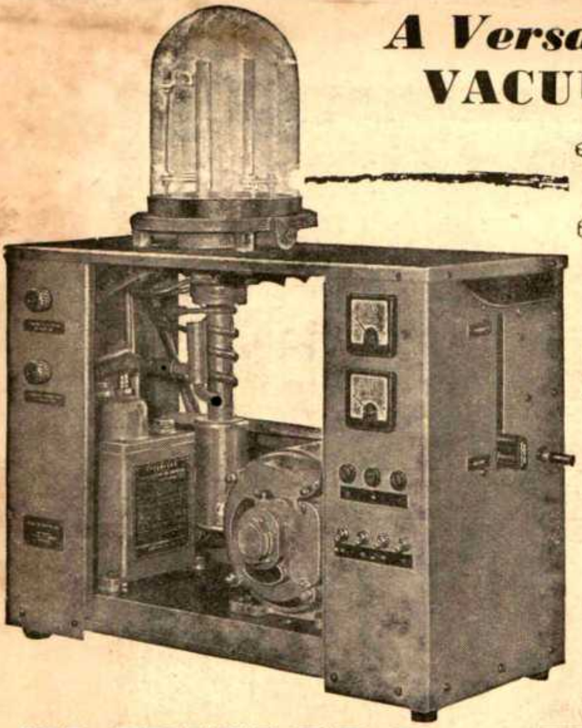
- *Visual* phase-change measurements to very fine limits
- The *weighing* of cells and parts of cells
- *Continuously-variable*, halo-free images of unstained material in colour or intensity contrast
- Observing *phase-gradients* as well as abrupt changes in optical homogeneity

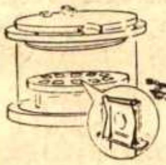
Objectives ×10, ×40, ×100, shearing or double-focus form, available.
Literature will gladly be supplied on request.

C. Baker
OF HOLBORN LTD. EST. 1765

Metron Works · Purley Way · Croydon · Surrey (Croydon 6644/9822)
Showrooms: 244 High Holborn · London · WC1

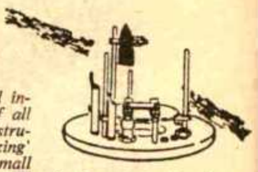
A Versatile Research Tool for VACUUM 'METALLIZING'





Evaporation or sputtering of H.F. quartz crystals with frequency control.

Anti-reflection and interference films of all types for optical instruments. 'Metallizing' plastic mouldings, small mirrors, etc.



Shadow-casting for electron and visual microscopy. Preparing thin films for electron diffraction investigation.

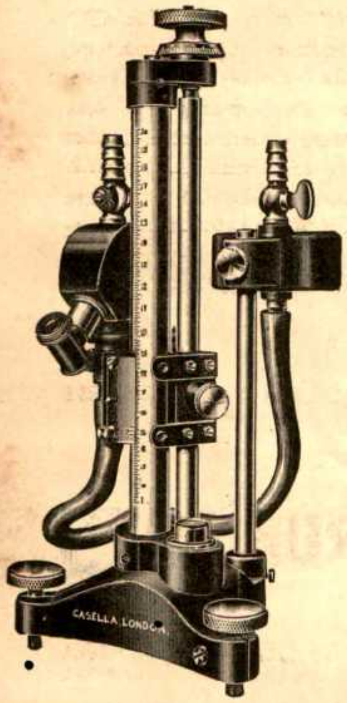
If you require to deposit thin metallic films for experimental, decorative or functional purposes, or wish to try out new production ideas, solve production snags and problems under the same working conditions as the industrial plant, this miniature pre-production research unit is the perfect answer—it REALLY is an extremely versatile high vacuum tool.

LET US SEND YOU FULL PARTICULARS

W. EDWARDS & CO. (LONDON) LTD
for better vacuum service

MANOR ROYAL · CRAWLEY · SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES: GLASGOW & TORONTO. AGENTS THROUGHOUT THE WORLD



CASELLA LONDON

MICROMETER READING MANOMETER

Reading to 0·001 inch of water

This instrument, which has a total range of 0–6·75 inch (0–170 mm.), enables readings to be taken to 0·001 inch (0·01 mm.) over the full range of the micrometer.

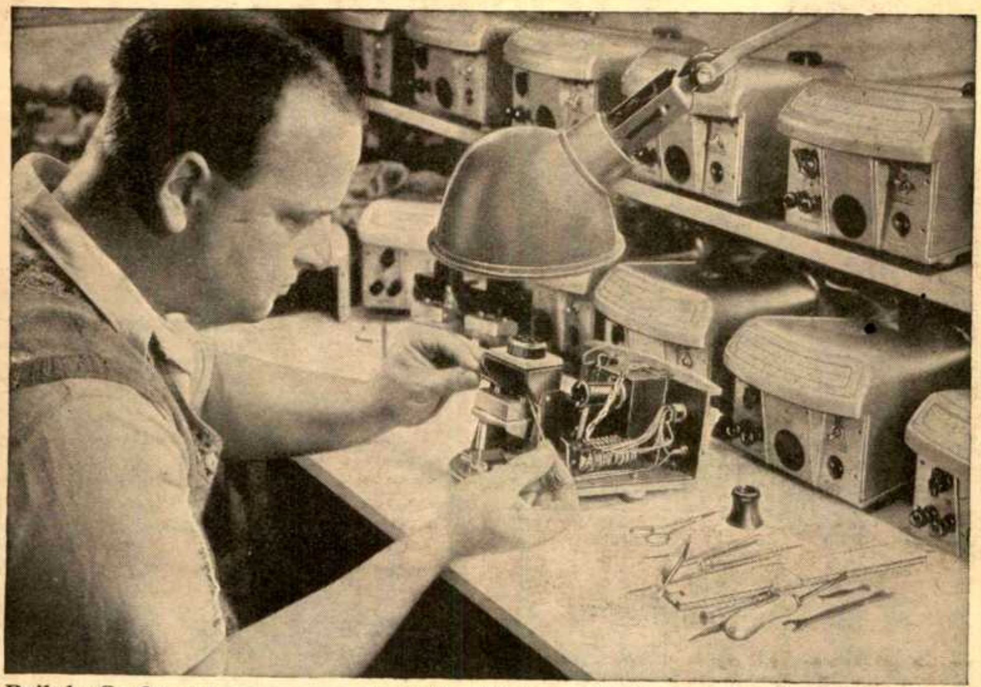
This Manometer is available from stock and full particulars will be supplied on application

C. F. CASELLA & CO. LTD.

Regent House, Fitzroy Square, London, W.1

Telephone: ★**EUSton 3944**

Member Scientific Instrument Manufacturers' Association of Great Britain



Built by Craftsmen · · · · · · · · · Assembly of Scalamp Galvanometers Cat. Nos. NT 7901/S-4/S

The **SCALAMP** *Range*

GALVANOMETERS · FLUXMETERS · ELECTROSTATIC VOLTMETERS

The illustration above shows the operator 'balancing the coil' of a "SCALAMP" GALVANOMETER — one of the final operations in its construction. This instrument, available in a range of sensitivities and incorporating a built-in four-position shunt, is one of the most versatile instruments of its kind. Housed in a robust dust-proof plastic case, it can be operated from mains or battery supply. Two new features, namely a slow-motion drive to the zero control, and an automatic self-shorting foot have recently been incorporated. The truly functional design of the case with built-in lamphouse, transformer and scale renders it adaptable to other instrument types. A FLUXMETER of exceptional performance and a series of ELECTROSTATIC VOLTMETERS (ranges 1-5, 3-10 and 5-18 kV) have already been introduced and a MEGOHM-PER-VOLT VOLTMETER is under development.
Details of the "SCALAMP" range will gladly be sent on request.

STANDARD EQUIPMENT IN MANY LEADING LABORATORIES

SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO. LTD. GRANTA WORKS · CAMBRIDGE · ENGLAND
WG.54

Trioctyl Phosphate

Phosphate 79

Tributoxyethyl Phosphate

These three plasticizers all confer outstanding low temperature flexibility on polyvinyl chloride and synthetic rubber formulations.

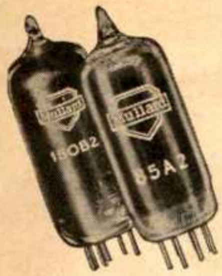
PILOT PLANT QUANTITIES ARE NOW AVAILABLE FROM

ALBRIGHT & WILSON

ORGANIC CHEMICALS DIVISION

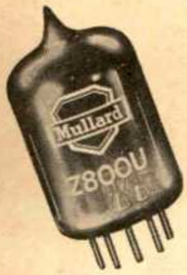
ALBRIGHT & WILSON LTD · 49 PARK LANE · LONDON W.1. Tel: GROsvenor 1311

TEW 454



STABILISERS & REFERENCE TUBES

Characterized by close tolerance burning voltages, very small voltage fluctuations, freedom from sudden large jumps throughout working current range, and long-term stability.



TRIGGER TUBES

Cold cathode tubes for particle counters and very low current stabilisers.

ELECTROMETERS

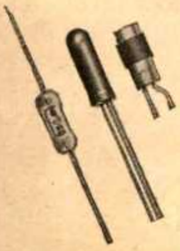
Triode and pentode octal and subminiature types for use with radiation monitors, photocells and other devices where a high input impedance is essential.

PHOTOCELLS

Vacuum and gas-filled photoelectric, and lead sulphide photoconductive types for light-activated relays and infra-red applications.

SPECIAL QUALITY VALVES

Special counterparts of popular types, designed and manufactured to withstand shock and vibration and to provide extra all-round reliability.



SEMI-CONDUCTOR DIODES & TRANSISTORS

A range of germanium diodes and transistors for scaling circuits, very low power H.T. generation and for trigger circuits.

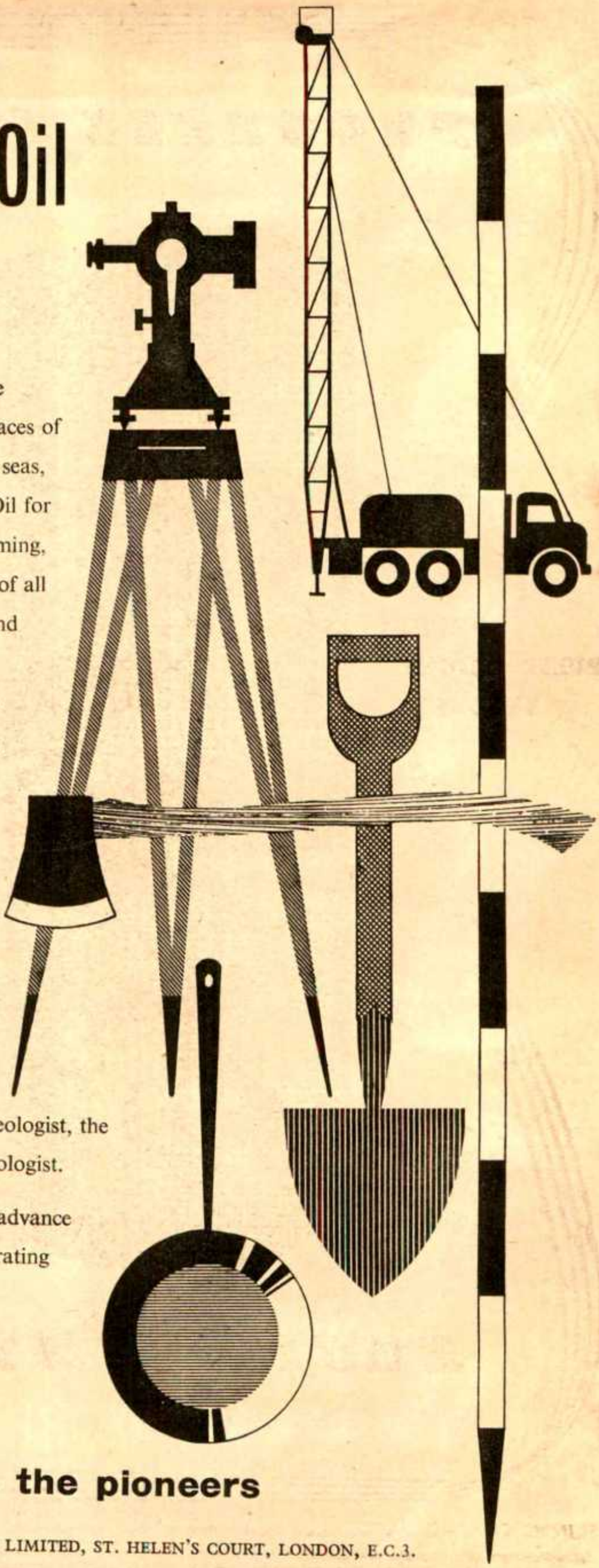
Valves and Tubes for Nuclear Physics

Among the valves and tubes in Mullard's comprehensive range are many that are suited for the most specialised and complex applications. Whatever your interest in electronic valves and tubes, your enquiries will be welcomed at the address below where full technical details and characteristic curves are available.

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT.,
CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MVT155



Pioneering for Oil

TO THE OILMEN of today goes the credit, and the adventure, of opening up many of the waste places of the earth. Under deserts, prairies, marshes and seas, otherwise bleak and unharvested, may lie oil. Oil for lamps, for cooking stoves, for industry, for farming, for the world on wheels, the ships and aircraft of all nations. The oilmen must always go out and find new sources of supply, so great is the demand. They must drill the wasteland to dredge up the liquid treasure that the earth holds imprisoned.

But that treasure has to be located first. More than a million wells have been drilled for oil through the earth's surface during the last ninety years. But only a fraction of these exploratory drillings have found oil.

Shell Research is constantly advancing the science of oil-finding. Today the aeroplane, the helicopter and the seismograph (measuring waves from man-made earthquakes) help the geologist, the geophysicist, the mineralogist and the palaeontologist.

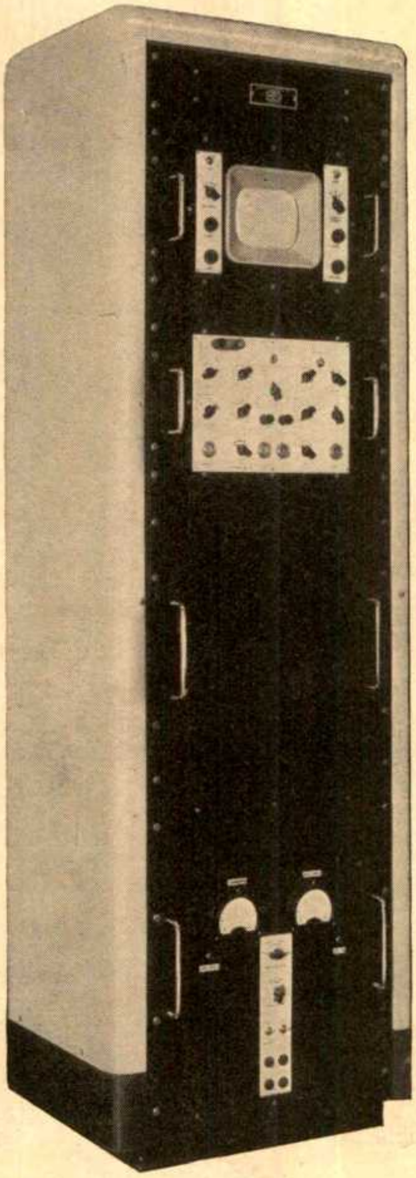
The search for oil is still an adventure, still an advance into the unknown. The oilmen are like the migrating cranes in Homer, settling ever onwards.

SHELL research backs the pioneers

THE SHELL PETROLEUM COMPANY LIMITED, ST. HELEN'S COURT, LONDON, E.C.3.

PROGRESS IN CONTROL

SUNVIC
PULSE HEIGHT
ANALYSER



An instrument for the analysis of a complex pulse amplitude spectrum into groups of known height according to their voltage amplitude.

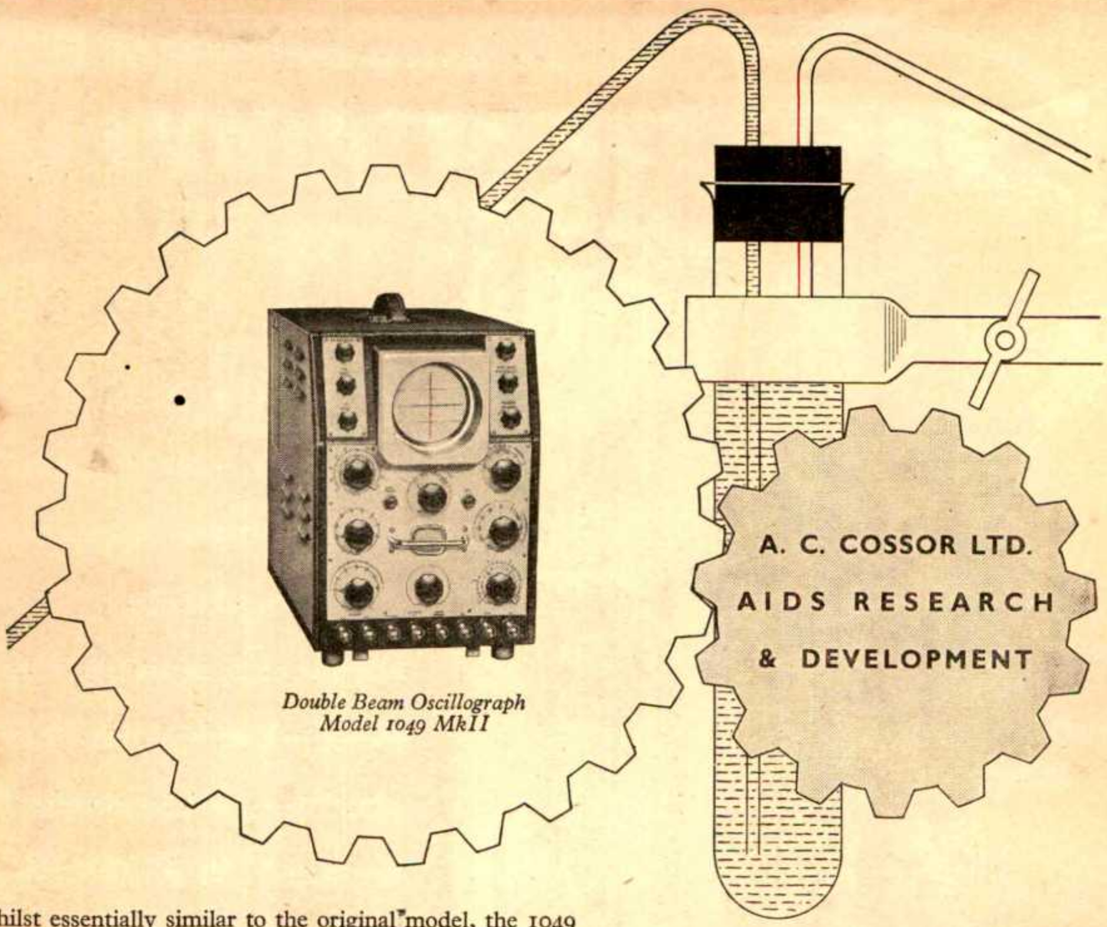
It displays up to a maximum of 120 channels and can store 1,200 binary digits. The design is based on that of Hutchinson & Scarrott (*Phil. Mag.*, 42, 792, 1951) and the instrument is made under licence from the N.R.D.C.

EQUIPMENT BY SUNVIC

SUNVIC CONTROLS LTD. (Special Products Division), No. 1 Factory, Eastern Industrial Estate, Harlow, Essex. Telephone: Harlow 24231/5

Manufacturers of Pneumatic and Electrical Instruments for detection, measurement, control and recording of Temperature, Flow, Liquid Level, Specific Gravity and Pressure, in Science and Industry. Vacuum Pumping and Measuring Equipment, etc.
Member of the A.E.I. Group of Companies.

TAS/Sc.305



*Double Beam Oscillograph
Model 1049 MkII*

Whilst essentially similar to the original model, the 1049 Mk. II provides added reliability against high voltage breakdown by the use of a sealed, oil-filled E.H.T. power transformer. The instrument meets the requirements of Industry and the Research fields of Physics and Medicine by providing an oscillograph for the display and measurement of phenomena of zero or very low frequency and those where amplifier bandwidths of up to 100 Kc/s are required. The oscillograph incorporates the Cossor 4″ flat-screen Double Beam tube (type 89) operating at 2 Kv but provision is made for operation at 4 Kv when maximum spot brightness is required. The amplifier circuits are direct-coupled throughout and provide independent amplifying channels for the Y1 and Y2 Beams with a gain of 900 and 25 respectively from zero frequency to 100 Kc/s. Input signal voltages and frequency may be measured on either channel using the calibrated dials and special anti-parallax graticule. The direct-coupled Time Base is arranged to provide a repetitive or triggered scan with a time range of 1.5 seconds to 150 micro-seconds and can be synchronized from a pulse derived either from the internal work circuits or from an external source. A continuously variable control adjusts the amplitude of the sync. or trigger signal and selects the polarity of the pulse from which synchronization is desired. "Z" modulation system is incorporated for time-marking purposes. Stabilization against mains variations up to 10% is provided for amplifiers and cathode ray tube supplies. Long period stability is reached within 5-10 minutes of switching on. A pre-amplifier (Model 1434) and photographic recording equipment is available for this oscillograph.

The Technical Advisory Staff of the Cossor Instrument Division is always at your service.

COSSOR **ELECTRONIC INSTRUMENTS**

Please address enquiries to

A. C. COSSOR LIMITED · INSTRUMENT DIVISION (Dept. 34) · HIGHBURY GROVE · LONDON, N.5

Telephone : CANonbury 1234 (33 lines) *Telegrams :* Cossor Norphone London *Cables :* Cossor London

C.I.62

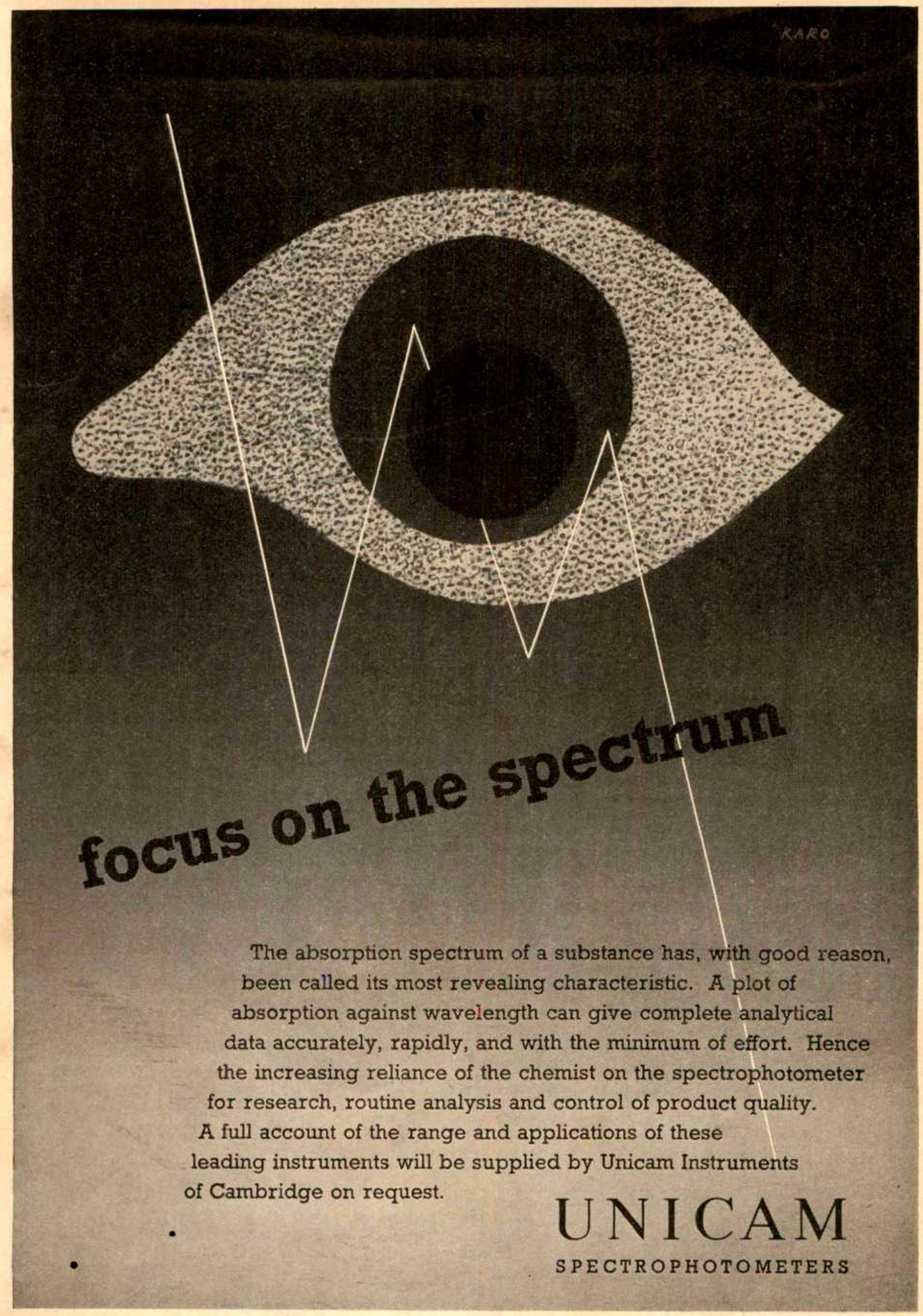
Wherever you need distilled water — in laboratory, factory or shop — you can use 'Deminrolit Water' with equal results. The Portable 'Deminrolit' plant operates by ion exchange and delivers water substantially free from dissolved solids. Running costs are measured in pence instead of in pounds, and you can thus use distilled quality water for many purposes where the cost of distillation would prove prohibitive.
Please write for Technical Publication No. 62 which gives full details.

HIRE SERVICE

Why not try demineralised water in your industry? You can do so easily and cheaply by hiring from us, at a nominal rental for a trial period, the latest Mark II Model Portable 'Deminrolit' Plant. Details of this service will gladly be supplied on request.

PERMUTIT 'DEMINROLIT'

THE PERMUTIT COMPANY LIMITED
(Dept. V.H. 173), Permutit House, Gunnersbury Avenue, London, W.4. *Telephone : CHIswick 6431*



The absorption spectrum of a substance has, with good reason, been called its most revealing characteristic. A plot of absorption against wavelength can give complete analytical data accurately, rapidly, and with the minimum of effort. Hence the increasing reliance of the chemist on the spectrophotometer for research, routine analysis and control of product quality. A full account of the range and applications of these leading instruments will be supplied by Unicam Instruments of Cambridge on request.

UNICAM
SPECTROPHOTOMETERS

U.137

NATURE

No 4446 SATURDAY, JANUARY 15, 1955 Vol 175

CONTENTS

Page
Supply of Science Teachers in Britain 93

Lectures by Sir Henry Dale By Prof J H Gaddum, F R S 95
Flow Properties of Disperse Systems 95
Interpretation of Earthquake Data By Ernest Tillotson 96
Elementary Applied Psychology By W H N Hotopf 97
Bird Physiology By Dr A J Marshall 97

Production of Enriched Non-radioactive Isotopes at Oak Ridge National Laboratory By Dr C P Keim 98
Production of Electromagnetically Enriched Stable Isotopes at Harwell By Drs W D Allen, R H Dawton, M L Smith and P C Thonemann 101
John Ray, F R S (1627–1705) By Joan M Eyles 103

Obituaries

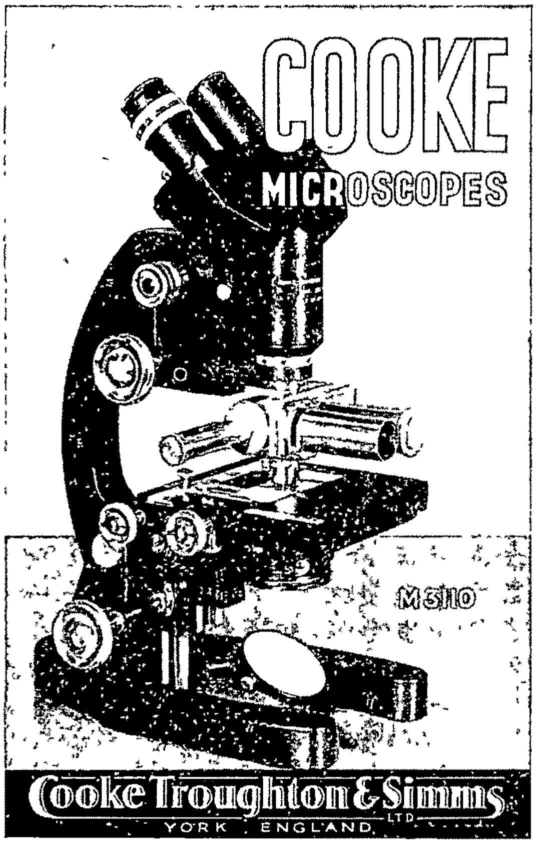
Prof H S Carslaw By Prof T G Room, F R S 105
Sir Frederick McMaster By Prof J R A McMillan 106

News and Views 106

Industrial Management in Europe By T H Hawkins 110
Determination of Vitamin A in Natural Products and in Margarine 111
National Research Council of Canada Annual Report for 1953–54 113
Experimental Investigation of Leaf Formation, Symmetry and Orientation in Ferns By Prof C W Wardlaw 115
A New Absolute Hygrometer of High Accuracy By Dr R G Wylie 118

Letters to the Editors

Specificity of Creatine Phosphokinase —Prof A H Ennor, H Rosenberg and Dr M D Armstrong 120
Mode of Action of Tetanus Toxin —V B Brooks, D R Curtis and Prof J C Eccles, F R S. 120
Effect of Background Activity on the Action of Acetylcholine on the Electrical Activity of the Brain —Dr J Crossland and J F Mitchell 121
Long-term Suppression of a Permeability Response of the Rat's Hind-paw by Cortisone, by Hypophysectomy and by Protein-deficient Diet —Dr E Kelemen, B Tanos, L Hajdu and P Forgacs 122
A Colorimetric Reaction for the Estimation of Cortisone, Hydrocortisone, Aldosterone and Related Steroids —Dr Irwin Clark 123
Differences between Rates of Metabolism of Benzene Hexachloride in Resistant and Susceptible Houseflies —F J Oppenoorth 124
Lysis of Human Pathogenic Bacteria by Myxobacteria —Miss S Mathew and Dr A Dudani 125
Relationship of Ovarian Hormones to the Pyogenic Effect of *Corynebacterium pyogenes* —George Eric Lamming, Alan Seaman and Malcolm Woodbine 126
Competition among Wild Rats —S A Barnett 126
Black Grub Infection in *Catla catla* —Mrs Florence G Abraham and M Anantaraman 127
Molecular Orientation in the Wings of a Termite —Ralph Hume 128
Photoelectric Cell Observations of Insects in Flight —I R Richards 128
Optical Rotation and Polypeptide Chain Configuration in Proteins —Carolyn Cohen 129
Gamma-Rays from Proton Bombardment of Sodium —K Nybo and T Grotdal 130
Paramagnetic Resonance in Copper Phthalocyanine —J E Bennett and Dr D J E Ingram 130
Fixation in Electron Microscopy —F W Cuckow 131
Allotropes of Tungsten —M G Charlton and G L Davis 131
Fine Structure of Solar Radio Transients —Grote Reber 132
Preparation of Dry Nitrocellulose Membranes and Nitrocellulose Particles —S Jacobs 133
Chromatography and Paper Electrophoresis of Sulphonphthalein Dyes —G T Franglen 134



Ready end of January

THE ANALYSIS OF DRUGS AND CHEMICALS

by

N EVERS, Ph D and W. SMITH, B Sc

Compiled with close reference to the current editions of the *British Pharmacopoeia* and *British Pharmaceutical Codex*, this volume contains monographs on all the more important pharmaceutical materials, as well as a great number of other substances which are increasingly used in medical practice, food manufacture, agriculture and the chemical industry

pp 550 Price **60s.** net

Charles Griffin & Co. Ltd
42 Drury Lane, London, W.C.2

$$

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to all Leading Universities, Public Libraries and Institutions of the World. Catalogues issued

★

SELLING?

Specialists in Scientific, Technical Books and Publications of all Learned Societies

★

Why not consult us first?

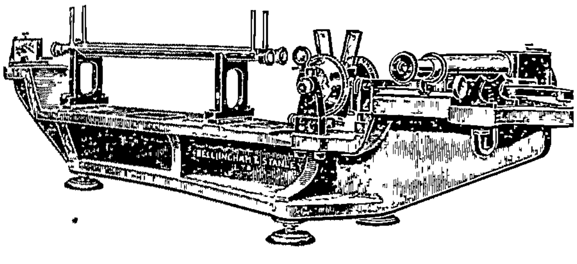
102 WIGMORE STREET, LONDON, W.1
Telephone Wel 7948, *Amb* 5991

$$

PRECISION B&S INSTRUMENTS

Jamin Refractometer

for liquids or gases



Average accuracy in measurement of refractive index is approximately 0 000001 for gases and 0 000002 for liquids.

The elimination of all spring adjustment to the mirrors results in great stability and freedom from vibration. Worm wheel gearing actuates the compensator. Tubes up to 50 cm. length can be used

Bellingham & Stanley Ltd.
DEPT. N, 71 HORNSEY RISE, LONDON, N.19
PHONE ARCHWAY 2270

SUPPLY OF SCIENCE TEACHERS IN BRITAIN

ATTENTION has been focused on the continuing shortage of science teachers in Britain by the reports of the Federation of British Industries and of the Advisory Council on Scientific Policy, by a resolution at the annual meeting of the Trades Union Congress and by a discussion at the Conference of the Universities of Great Britain and Northern Ireland held in London during December 17 and 18. Naturally, the subject has also been discussed during the recent meetings of educational bodies The term 'science teachers' refers to teachers of science or mathematics in public schools, grammar schools or other schools with a significant number of sixth-form pupils It is now accepted that there is a shortage of science teachers, that their quality is lower than it was before the War, and that the shortage is a matter of national concern because it threatens the supply of science students to the universities and so the supply of scientists to industry—and hence the standard of life of the whole community It is also clear that the shortage will continue for some decades, unless prompt measures are taken, because of the growing demand of industry and the Scientific Civil Service for more scientists and technologists

The situation demands two things first, prompt measures to alleviate the present situation , secondly, an analysis of the fundamental causes of the shortage and the reluctance so far shown to take steps to end it, so that long-term remedies can be applied to secure for the schools a full supply of science teachers of good quality, which must be done before the greatly increased supply of scientists needed by the community will be forthcoming The reports of both the Advisory Council on Scientific Policy and the Federation of British Industries rightly stress that the only permanent solution for the shortage of science teachers is the production of more science graduates , but they fail to emphasize that more science graduates cannot be produced until the shortage of science teachers has been made good

A number of minor suggestions for immediate action to alleviate the present shortage were made in the report of the Federation of British Industries, and also by speakers at the Universities Conference Many of them have been common practice for the past five years in schools—at best they are merely palliatives They cannot of themselves reverse the trend which has set up the present deflationary spiral of fewer science teachers leading to fewer science graduates, producing still fewer science teachers and so on But there are two immediate steps which, if taken, might materially reduce the present shortage of science teachers—they might even reverse the deflationary spiral. Scientists are in short supply , during the Second World War, articles in short supply were rationed Something similar might now be attempted for scientists A high-level conference of the interests using scientists—the Scientific Civil Service, industry, the universities and the schools—should be called to try to secure a fairer distribution of scientists Direction of labour is clearly out of the question , but, when industry and the Scientific Civil Service know the facts, they might be ready to help themselves in the long run by decreasing their demands for scientists for a time, and so help the schools to get more science teachers now This suggestion was the leading recommendation of the report issued in November 1953 of the National Advisory Council for the Supply and Training of Teachers , but no action was taken The Minister of Education ought to have taken the initiative, and that no such conference has taken place suggests lack of courage and faith in the grammar schools, it is the task of the present Minister to convince his colleagues in the Government that the grammar schools hold the key to the solution of the problem of the shortage of scientists The Advisory Council on Scientific Policy would then be a suitable body to which this fairer distribution of scientists could be immediately referred

An apt analogy was recently given by Dr. A W Barton, headmaster of the City of London School After the War, Britain was short of coal, its most precious and most abundant raw material, because there were not enough miners , so coal mining was made a form of national service, and this has had some effect in attracting more men to the mines and increasing production We are now short of a precious human commodity, science teachers , therefore, the possibility of recognizing teaching as a form of national service should be considered This would increase the number of science teachers coming into the schools in the year it was introduced from six hundred to nine hundred, because men teachers coming into the schools at the end of their national service would be joined by an equal number who had just graduated and would just have been starting national service in the Armed Forces It might also do something towards a permanent solution of the problem by attracting some new men into teaching, some of whom would like it and would stay on The compromise on national service proposed in the report of the Federation of British Industries is satisfactory neither to the Armed Forces nor to the schools The Armed Forces can make no use of men who are to have only the six months or so needed to complete their basic training The compromise is unfair to the schools because it fails to do justice to the serious shortage of science teachers and their present importance to the country

The fundamental cause of the present shortage of scientists in general and science teachers in particular is the policy of full employment and the great increase in the demand for scientists since the War Two other factors in the shortage of science teachers in particular are the exaggeration of the importance and satisfaction of research, and the decline in the prestige and financial rewards of science teaching. The steps needed to reverse the deflationary spiral and abolish the shortage of scientists would therefore seem to be fairly clear The pre-war economic pressure due to unemployment, which provided that a sufficient number of science graduates should be available for teaching, disappeared when Britain adopted a policy of full employment, and science graduates must now be induced to go into teaching by pointing out to them the importance of the work and by suggesting to them that it is the duty of those with the right qualities to take up teaching Much might be done to this effect by arranging an annual visit to the pure science departments of each university by a headmaster or assistant master, during which third-year undergraduates and research students could be told by practising schoolmasters about the responsibilities, opportunities and rewards (financial and spiritual) of science teaching, such talks would also have to make clear the importance of science teaching in the national life The staffs of the universities could perhaps do more, through their considerable influence with undergraduates, to persuade them to consider teaching as a career, the help of the university appointments boards and the Youth Employment Service should also be sought

The schools themselves can help in a number of ways Headmasters should take care, so far as their authority permits, to give their staffs good working conditions inside the schools They could use their influence to try to persuade more pupils to stay on in the sixth form, they could stress the urgent national need for scientists when advising pupils on their choice of sixth-form studies, they could put the claims of teaching fairly before their pupils when advising them about careers Finally, boys and girls are influenced more by what their teachers are than by what they say If science teachers are keen, competent and devoted to their pupils, that in itself will induce in young people a respect for teaching as a profession and will result in more of them taking it up Local education authorities can help by giving to the grammar and other secondary schools the freedom and prestige which the grammar schools enjoyed before the War and have since lost, and by ensuring that science teachers are not passed by when headships are under consideration

There is no question that research attracts many graduates This is due partly to the spectacular achievements in recent years both of the physical and the biological sciences, which have led graduates to believe that this is the chief road to fame But they have often heard only about the successes, they fail to realize that these results often involve thousands of graduates and technicians, and they do not appreciate that research, like teaching and any job which is worth while, has its monotony, its failures, and perhaps more than its fair share of bewilderment and frustration. Some of the responsibility for the powerful attraction of research, however, is due to failure to maintain a proper balance in the universities between their two functions, teaching and research It has been suggested that too many of the teaching posts in universities are filled by men interested primarily in research The universities should re-examine the relative importance of teaching and research, of transmitting accepted truth to the next generation and of finding new truth If they fail in the first function, must not the second of necessity wither away ? When the universities have ensured that there is in each science department on man, of the status of a reader or occasionally a pro fessor, who holds his important post because he is distinguished teacher of his subject, then a highe proportion of undergraduates is likely to take u science teaching

We shall only get enough science teachers in thi age of full employment if we set out to produce youn men and women with the right qualities, namely, a interest in science and an equally great interest i persons One step which the universities could tak to produce young men and women likely to mak good science teachers would be to devise genera honours degree courses in which arts and scienc subjects could be combined While there is n evidence that there is undue specialization in scienc in the schools (indeed, in most schools all pupil spend two-thirds of their time on the humanitie until they reach the sixth form and begin t specialize), they must also help in this respect b providing stimulating courses in the humanities fo their science specialists, and using their influence t see that their pupils take this part of their curriculum seriously

Finally, headmasters in schools and professors i universities cannot in honesty tell their pupils how important science teaching is and appeal to the sense of duty of those suitably qualified to take it up, unless they can also assure them of reasonable financial reward Before the War, a science teache had the same salary as a university lecturer, and a senior science master the same as a reader or senio lecturer To-day the university lecturer rises to £1,350, whereas a science teacher rises to £950 unde a generous local authority, the senior lecturer rises to £1,600, while a senior science master rises to £1,200 with a very generous local authority or to £950 under a niggardly one The science teacher is clearly underpaid to-day When the Education Act was passed in 1944, it was decided that all children were to have a proper secondary education, which implies that all secondary schools should have classes of reasonable size, buildings with comparable amenities and teachers paid on a common salary scale This has meant that the salaries of the teachers in all types of school—primary, secondary modern and secondary grammar—are settled by a Burnham Committee in which grammar school teachers are very much in a minority This has produced the expected effect on the salaries of teachers, the pay of the average worker has been increased at the expense of the fewer highly skilled workers, and the highly skilled minority feels that it is being unjustly treated The Burnham Committee has been trying to work out a suitable salary scale for all teachers in the State schools for ten years, it has failed to do justice to the teachers in the grammar schools, which, from the point of view of progress and development, are the most important schools to the community, and it is clear that the Burnham Committee as at present constituted is very unlikely to solve this problem The Minister of Education has just asked them to decide if the salaries now being paid to grammar school staffs are good enough to attract distinguished teachers Unless the Minister's lead induces the Burnham Committee to award a substantial increase in grammar school salaries, a Royal Commission to consider the salaries of teachers in grammar schools and the problem of their recruitment appears to be desirable This question of salary is not the only factor to be considered, but it seems fairly certain that the present shortage of science teachers is unlikely to be overcome until more attractive salaries are offered.

LECTURES BY SIR HENRY DALE

An Autumn Gleaning

Occasional Lectures and Addresses By Sir Henry H Dale Pp x+225 (London Pergamon Press, Ltd , 1954) 21*s* net

IN 1953 the Pergamon Press published a collection of famous original papers by Sir Henry Dale under the title "Adventures in Physiology" (see *Nature*, 172, 825 , 1953) The same publishers have now persuaded Sir Henry to prepare a smaller book with a more general appeal containing thirteen lectures and addresses mostly delivered during the past ten years, and extracts from five war-time presidential addresses to the Royal Society

This book contains a mixed bag of good reading-matter written with easy and explicit fluency, and intelligible without specialized knowledge There is an account of the history of work on viruses up to 1935 The discovery of insulin is described with the authority of one who was in direct contact with the original work and yet able to be impartial The case for the freedom of science and the case for the inclusion of some knowledge of science as an essential part of a liberal education are put with convincing clarity and force There are two addresses to young men on "Experiment in Medicine" and on "Medical Research as an Aim in Life" The popular lecture on "Accident and Opportunism in Medical Research", delivered in Cambridge at the annual meeting of the British Medical Association in 1948, is particularly valuable since it contains interesting details, not given in the original publications, of how great discoveries have been made It is good to see in print the stories of the discovery of Ringer's solution through the laziness of a technician and of Dr Oliver's injections of adrenal extracts in his son

The book also contains addresses in honour of William Whitla, Thomas Addison and Lord Rutherford and the lecture given in connexion with the Festival of Britain reviewing a hundred years of medical progress The last two lectures are up-to-date reviews of a more technical kind dealing with two topics on which the author is the chief authority —the mechanism of anaphylaxis, and the transmission of effects from nerve endings

After an active life spent in leading the advance beyond the frontiers of knowledge in various specialized fields, Sir Henry has had the time between the ages of seventy and eighty years to turn his mind to problems of more general importance He has considered the place of science in the modern world and its effects on mankind , he has important things to say on these matters and the power to say them effectively This book is an anthology of his unmistakable and characteristic English prose and can be recommended to all who are interested in medical and allied scientific research J H GADDUM

FLOW PROPERTIES OF DISPERSE SYSTEMS

Flow Properties of Disperse Systems

Edited by Prof J J Hermans (Deformation and Flow Monographs on the Rheological Behaviour of Natural and Synthetic Products) Pp xi+445+12 plates (Amsterdam North-Holland Publishing Company New York Interscience Publishers, Inc , 1953) 35 florins , 70*s*

THIS volume is one of a series of monographs describing the rheological behaviour of natural and synthetic products The particular disperse systems with which it deals are those containing 'large' particles well beyond ordinary molecular size, but sufficiently small to exhibit, in some instances, marked Brownian motion , it is assumed that the laws of hydrodynamics of continuous fluids are applicable to such systems provided the particles have dimensions of the order of ten times the molecular dimensions of the dispersion medium

The ten chapters into which the book is divided treat of suspensions, emulsions, gels, dilute solutions of impenetrable rigid particles and flexible chain molecules, liquid sprays, atomization of liquids, foams, smoke and powders The field covered is therefore wide and diverse, and the various authors have had to select, from a considerable literature, those aspects which they regard as of particular significance in the development of their subject This limitation results in some lack of balance and some obvious omissions which are, however, in part made good by extensive references to standard works and to original papers

The rheological properties of suspensions, emulsions and gels have many characteristics in common best illustrated by a comparison of their visco-elastic behaviour , and much of the recent work described by R Roscoe, E G Richardson and J J Hermans in the first three chapters is concerned with the viscosity–concentration relationships of typical examples of the three systems The theoretical treatment is usually based upon hypothetical models of the molecules concerned , thus, for example, Kuhn, Wall, Hermans and Treloar have developed a theory of long-chain molecular networks applicable to rubber, and Kratky has used a model consisting of chains of rigid rod-shaped crystalline units joined by hinges and embedded in a continuous plastic medium to interpret the behaviour of cellulose gels In this way, quantitative expressions for force–strain relationships and the volume change on stretching have been derived

In recent years, a great deal of valuable data on the shape and dimensions of macromolecules and the structural characteristics of gels have also been obtained by a study of the flow characteristics of their solutions Ch Sadron and J J Hermans have given an excellent account of the theory of Brownian movement as applied to dilute solutions of impenetrable rigid particles and of the equivalent particle concept which has been used by Flory in the development of a theory of viscosity applicable to dilute solutions of flexible chain molecules

The extensive use of sprays, aerosols and smokes for insecticidal and other purposes has led to further studies of the mechanism of drop formation, distribution of drop-size and rates of dispersion and settlement of aerosols and smokes E G Richardson gives a comprehensive account of the break-up of liquid jets and the methods of measuring drop-size, while H L Green summarizes recent work on the atomization of liquids and the properties of smokes R Matalon describes the rheological properties of foam and the methods available for studying the mechanical properties of the stabilizing surface layer of laminæ and bubbles The concluding chapter by Mrs B S Neumann contains an account of the flow properties of powders

INTERPRETATION OF EARTHQUAKE DATA

Earthquake Intensity and Related Ground Motion
By Frank Neumann Pp v+78+figures 1–16 (Seattle University of Washington Press, 1954.) 1 50 dollars

THE author of this booklet is a noted mathematician and was employed for a prolonged period as chief seismologist at the United States Coast and Geodetic Survey, retiring in August 1953 The booklet surveys part of this work and summarizes our present knowledge of this most important part of seismology, including much original and previously unpublished work by the author It is a publication replete with experience and written with the incisiveness and succinctness of the mathematician

The old way of determining earthquake epicentres by drawing isoseismal lines required the precise formulation of seismic intensities, and in 1931 H O Wood, at the Pasadena Seismological Laboratory, brought up to date the Mercalli–Cancanni intensity scale Now seismic intensity, which is in effect a measure of the local destructiveness of an earthquake, is made up of a great number of factors, chief among which is probably local ground acceleration Nowadays, ground acceleration alone is measured by 'strong-motion' seismographs In 1935, C. F Richter published an earthquake magnitude scale in which the magnitudes of earthquakes are obtained from the measurements of standard seismograms reduced to standard epicentral distances, and are a function of the energy released by the earthquake The most recent formula of B Gutenberg and C F Richter is $\log E = 12 + 1\ 8\ M$, where E is the radiated energy and M the earthquake magnitude. Earthquake magnitude does not refer to local energy near the observatory, but to the total energy released at the focus of the earthquake

Efforts have been made, and are being made, by seismologists throughout the world to define seismic intensity with mathematical precision, obtaining the data from seismograms instead of from human perception and the destruction of buildings, and to relate seismic intensity at any focal or epicentral distance to earthquake magnitude at the focus of the earthquake This is precisely the task Frank Neumann set himself In the present booklet he develops a distance–Modified Mercalli intensity relationship, particularly from the data concerning the Puget Sound earthquake of April 13, 1949 The intensities are the lowest intensities and refer to the basement rock outcrop In all earthquakes the intensity on this formation is reduced approximately one grade whenever the distance is doubled This distance–intensity graph always indicates an epicentral intensity corresponding to the Gutenberg–Richter magnitude at an epicentral distance of about one mile Intensities on highly compacted sedimentary rock outcrop are consistently about one Modified Mercalli grade higher than on granitic outcrop at all epicentral distances A relationship is established between Modified Mercalli intensity and maximum acceleration This relationship varies with epicentral distance With increase of epicentral distance the acceleration for a given Modified Mercalli intensity grade decreases, but the duration increases

Period-acceleration envelopes exhibit the following characteristics At short epicentral distances they show a peak on the average at about 1/3 sec period, but the period of the maximum acceleration waves increases with epicentral distance For the waves of shorter period the rate of increase of acceleration with increase of period is indicative of body-wave propagation and apparently varies greatly with the type of rock traversed and epicentral distance For waves of longer period the rate of decrease of acceleration with increase of period is practically constant and indicative of layer vibrations in, or related to, basement rock formations. The author develops a technique, employing intensity-acceleration relationships, whereby Modified Mercalli intensities are determined from period-acceleration envelopes They consistently agree with the intensities obtained from the author's distance–intensity graphs Further, a quantitative intensity grid developed by the author from the intensity-acceleration and period-acceleration relationships, and valid up to an epicentral distance of approximately twenty-five miles, shows the acceleration or amplitude to expect for any period that may be in the ground motion. Modifications for distances exceeding twenty-five miles are discussed. Grids are developed for period-acceleration distribution when earthquake foci are in the granitic basement, and for period-acceleration distribution when earthquake foci are in the highly compacted sedimentary rock above Grids are used to interpret period-acceleration envelopes, or individual waves, in terms of Modified Mercalli intensity

The author states that "since the intensity distribution on basement rock is always very uniform, so-called basement rock intensity data may be used to determine maximum intensity epicentres These are points of maximum energy release and do not necessarily coincide with epicentres obtained from standard seismograph records, which indicate the location of the first rock break where more than one break occurs The rapid decrease of intensity on basement rock outcrop with increase of distance in the immediate epicentral area indicates that major rock breaks are quite limited in extent The intensity distribution in all shocks thus far studied is the same as though the foci were all very shallow regardless of the actual depths revealed by teleseismic data". A casual comparison of period-acceleration envelopes and earthquake spectra obtained from identical instrumental records reveals a marked similarity in their overall forms Further study, however, is needed to determine to what extent such envelopes may be used as substitutes for earthquake spectra

The use of simplified ground motions in engineering studies as substitutes for actual ground motions poses a difficult problem. While the quantitative intensity grid as developed by the author furnishes period and amplitude data on earthquakes of different Modified Mercalli intensity, the important element of duration s missing, as Neumann admits. He suggests, however, a substitute procedure. He further states that a '22-fold increase in acceleration is indicated" when arthquake vibrations passing through the granitic asement force the most responsive types of surface ormations into vibration. (The United States Bureau f Mines, while investigating high-frequency explosion vaves, found a thirty-fold increase between two xtreme types of rock and soil formation.)

The author is at pains to direct attention to the rovisional character of all the new relationships ut forward in the text, and suggests new types of nstruments, which at low cost would assist the ractical and theoretical investigations brought to ight by this erudite booklet. Engineers concerned vith earthquake-proof design and those concerned vith insurance in countries liable to earthquakes, o less than all seismologists, will read this stimulating vork with interest and profit. ERNEST TILLOTSON

ELEMENTARY APPLIED PSYCHOLOGY

Psychology applied to Human Affairs

By Prof. J. Stanley Gray. Second edition. (McGraw-Hill Series in Psychology.) Pp. vii+581. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 12*s*. 6*d*.

THIS book is designed as a 'class-room text-book' for first-year students in psychology. Its major emphasis is on industrial psychology. The reatment of educational, clinical and medical psychology is very slight. Some of the less orthodox opics it deals with are "Psychology in College Life", 'Military Psychology", "Speech Correction", and 'Psychology in Marketing and Advertising". Social psychology, too, is represented in chapters on "Public Opinion and Propaganda" and "Crime and Crime Detection". Since the book is written at a fairly lementary level, it is to be expected that the changes rom the first edition, published in 1946, are small. The main justification for the new edition seems to e the bringing up to date of descriptions of the ractice of some American institutions that make use of applied psychology.

The editor, who is also author of nine of the nineteen chapters, emphasizes that the book aims at eing "factual and practical", and "theoretical discussion . . . has been kept at a minimum", and hat sometimes, because of limited space, "facts are eported with a minimum of interpretation". Hence 'it needs a teacher to interpret the facts", though he editor suggests that by using this as a classroom ext-book the teacher can dispense with formal ectures. This may excuse what sometimes appears nconsequent and arbitrary. But the approach could e more scrupulous. Too often results of dubious alue are quoted without tests of significance or, in ome cases, indication of the number of cases upon which the results are based. The writers take the eader too little into their confidence about the roblems and difficulties facing the applied psychologist, and the presentation by topic leads to a neglect f questions of method. The interview, for example, s basic to a number of topics dealt with in this book; ut no writer has the space to give it the systematic reatment it deserves. Some good features of this ook—statistics showing the need for applied psychology in various fields, descriptions of the institutions that carry it out—are of less value to readers in Great Britain since they refer almost entirely to America. In particular, the very cursory chapters on clinical and military psychology are robbed of their value by this practice.

The standard of text-books in psychology is perhaps a modest one, and by such a criterion this book may not be much below average. But it may be questioned whether its loose, episodic structure makes it a satisfactory compendium of subjects that more specialized text-books in particular fields of applied psychology already cover adequately in university courses. W. H. N. HOTOPF

BIRD PHYSIOLOGY

Avian Physiology

By Prof. Paul D. Sturkie. Pp. xii+424. (London: Baillière, Tindall and Cox, Ltd., 1954.) 48*s*.

ONE might cavil at the use of the above title for a volume that deals essentially with the physiology of the domestic fowl, duck and pigeon. But when we reflect that 90 per cent or more of "text-books of physiology" are in fact text-books of rodent, rabbit and human physiology, any criticism of the title chosen by Prof. Paul D. Sturkie would be a little unfair. The present book is, in fact, probably the first in any language devoted solely to the physiology of birds.

The book deals comprehensively (five chapters) with what is known of avian blood and its circulation, including a chapter on electrocardiography. Three chapters give information on those enormously interesting subjects, avian respiration and the regulation of body temperature. Another one is devoted to energy metabolism, including a statement of what is known (and what is not known) concerning the mechanism that governs moult. Mechanical and chemical aspects of alimentation are dealt with, and there is a chapter on carbohydrate metabolism.

There are also chapters on renal physiology, the special senses (but not the nervous system) and reproduction, together with an account of early embryonic development. The final five of the twenty-one chapters deal with the endocrine glands and their relationships.

This book may become indispensable to the numerous workers in what has become known as poultry science in the United States and elsewhere. It could be valuable, to a limited degree, to the ornithologist who has sufficient physiological grounding to understand it.

The principal criticism that must be made is that, written chiefly for research workers in a very specialized economic field, the book ignores great bodies of available knowledge that vitally need to be written into a single volume. There is nothing about digestion in fish- and flesh-eaters, or the mechanics of, or the remarkable adaptations towards, locomotion. The highly suggestive work of Wood Jones on olfaction in the Turbinares has been ignored and there is little about the neuro-endocrinal control of display, breeding seasons and migration. Perhaps we may hope for a later expansion of the volume to make it truly a text-book of avian physiology. There can be few people better equipped to do this than Prof. Sturkie. A. J. MARSHALL

PRODUCTION OF ENRICHED NON-RADIOACTIVE ISOTOPES AT OAK RIDGE NATIONAL LABORATORY

By DR. C. P. KEIM
Oak Ridge National Laboratory, Oak Ridge, Tennessee

THE production-scale mass spectrographs at Oak Ridge, originally developed to enrich uranium-235, now provide more than two hundred different enriched isotopes of nearly fifty elements for basic and applied research.

Only four of the large mass spectrographs are in active operation for general isotope separation. These were originally installed to provide training facilities for production personnel and to develop ion sources and isotope collectors to be used in large-scale enrichment of uranium-235. These four mass spectrographs, arranged as pairs in two separate magnetic fields, have proved to be highly versatile in enriching naturally occurring isotopes of many elements from lithium to uranium in mass. Radioactive isotopes, artificially produced, have also been separated to a limited extent.

The Production Mass Spectrographs

These Oak Ridge electromagnetic isotope separators (sometimes referred to as calutrons, since the production models were developed at the Universit of California, under Prof. E. O. Lawrence) consist o an ion source and an assembly of isotope collecto pockets mounted in a vacuum chamber between th poles of a powerful electromagnet. The gap betwee the poles of the magnet is 12 in. in one case an 24 in. in the other; the magnetic field may b regulated at whatever strength is desired, up to a least 10,000 gauss. The operating vacuum is in th vicinity of 10^{-5} mm. of mercury. Fig. 1 shows th front view of a calutron and Fig. 2 is a photograp of a model of the magnet, the bins and the vacuu pumps.

A suitable charge material of the element, th isotopes of which are to be separated, is vaporize and fed into the graphite ionization chamber. Electrons of a few hundred volts energy from a tungste or tantalum filament are directed through a collimating slot into the ionization chamber, wher collisions with the gaseous charge material result in a high number of positive ions. These ions are the accelerated from the ion source by means of a

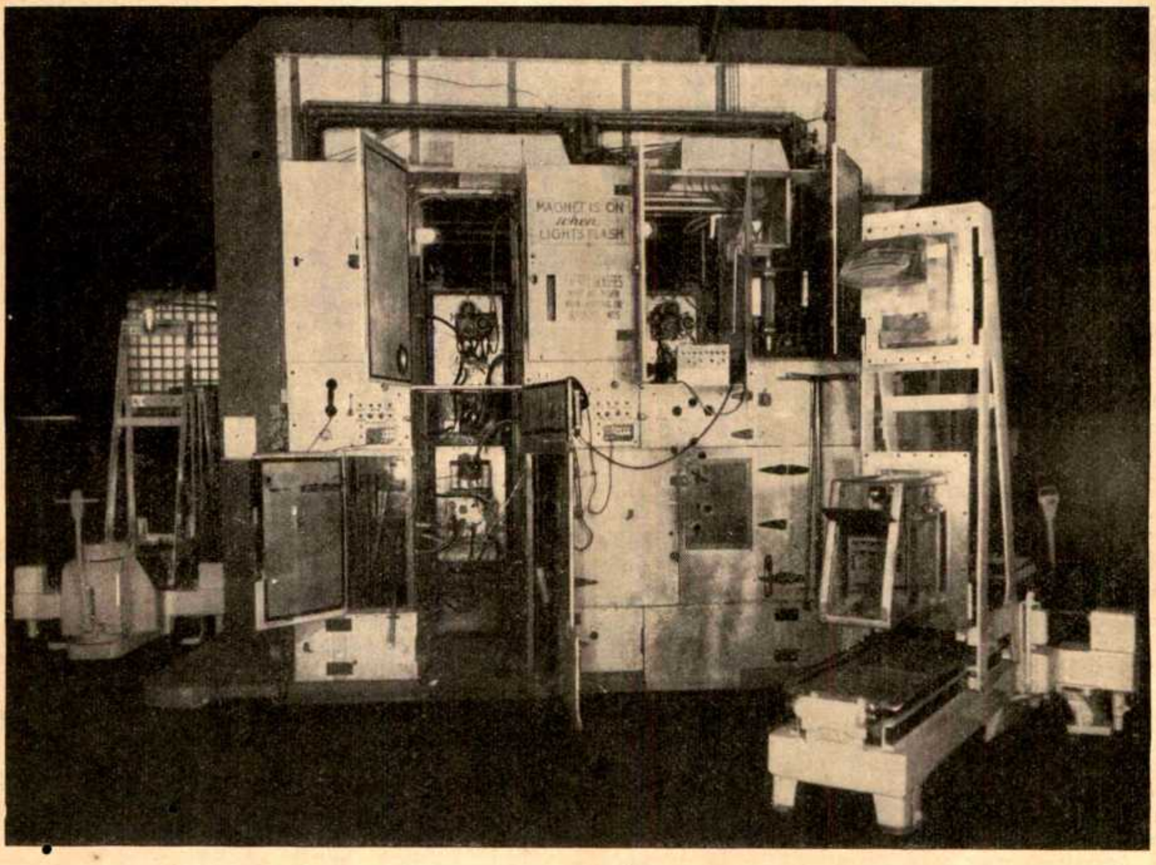


Fig. 1. Front view of the calutron assembly showing the magnet yoke, mass spectrograph spaces, and a handling truck on which are mounted an ion source (below) and the isotope collector (above). The left bin doors are open showing the ion source (below) in its port with all electric and water connexions made and the isotope collector (above) ready for operation. The right bin has the lower doors closed to protect personnel from high voltage during operation

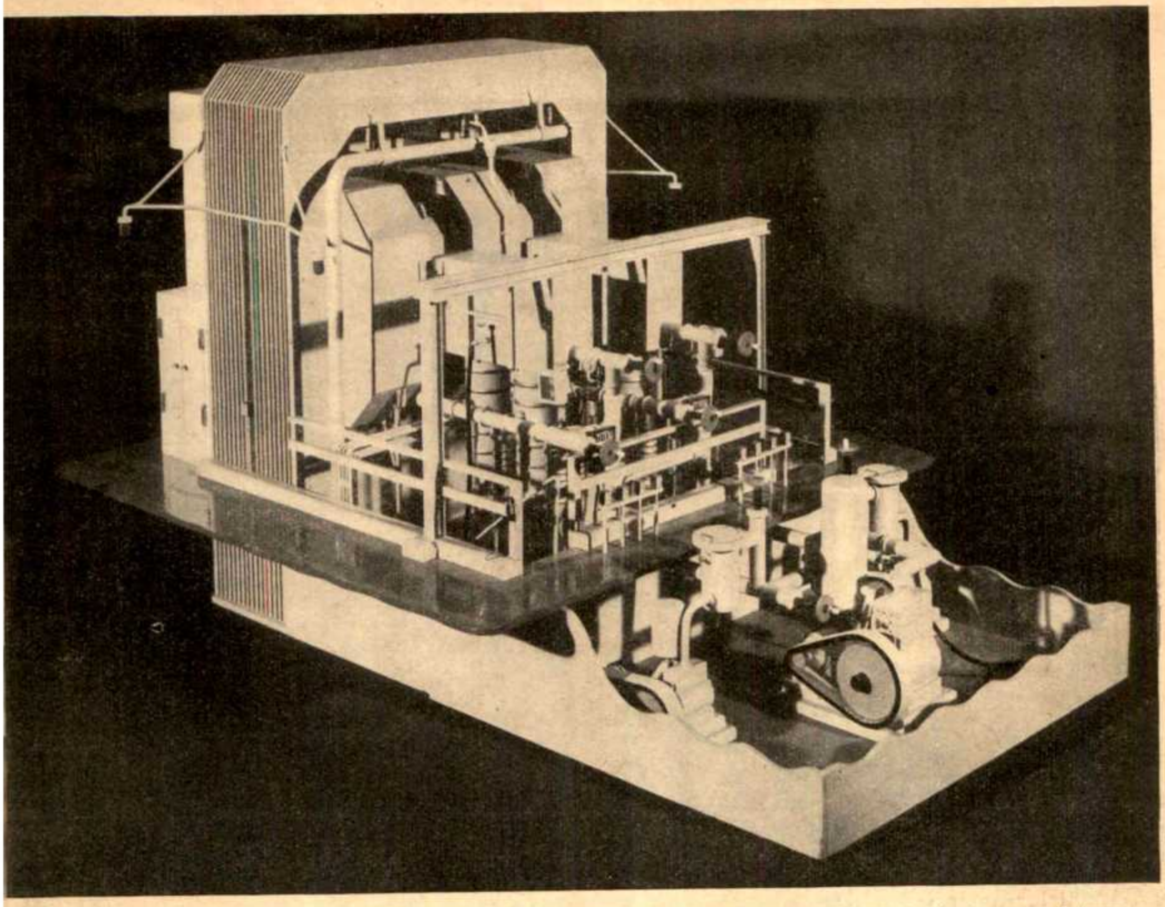


Fig. 2. Rear view of a model of the calutron assembly showing the magnet yoke, three vertical magnet coils, two spaces between the pole-faces of the magnet each for a mass spectrograph, vacuum pumps, valves and piping systems. The mechanical vacuum pumps are on a floor below the main operating level

ectric field of 35 kV. As the ions travel across the agnetic lines of force they are further accelerated to a circular path ; the radius of travel can be aried from 6 in. up to 48 in.

At the 180° position the ions, now separated ccording to mass, are directed into isotope collectors t ground potential. Usually the isotopic material is tained in these collectors in its elemental state.

It has been found that the singly charged ions of e element are the most plentiful. Fig. 3 indicates e variety of ions emerging from the ion source uring typical operations.

Observations drawn from Processing Experience

Various observations have been made in the proessing of nearly a thousand lots of separated isotopes f many elements since early 1946.

The halides have usually proved to be the best harge materials, although oxides and the element self are sometimes preferred. Ion-source oven mperatures may be successfully operated at temeratures as low as 100° C. up to more than 2,500° C. ne or more ionization arcs may be mounted on one n-source assembly, with corresponding increase in roductivity, if there is not too much overlapping of e isotopes at the collector pockets.

Failure of the tantalum or tungsten filaments hich supply electrons for ionization is the most ommon cause of interruption of isotope separation runs. This failure is due to positive ion bombardment and chemical attack.

The percentage of material vaporized from the charge bottle actually getting to the isotope collectors varies widely, from only a few per cent up to as high as fifty per cent, depending on the element being processed.

Graphite collectors are preferable if the collected isotopes have a low vapour pressure and the collector pockets do not require water-cooling. Water-cooled copper collectors have proved best for isotopes of high vapour pressure to prevent high loss of the collected isotopes. Under adequate control, almost one hundred per cent of the material reaching the collector pockets can be successfully retained there.

Every element has its characteristic chemical and physical properties, and the performance of an element cannot be successfully predicted on the basis of the behaviour of similar elements.

Key Steps in Isotope Separation

The key steps in successful isotope separation require various technical skills. Inorganic chemists must aid in the selection of suitable charge materials of the elements to be processed, including rare and unusual materials, then prepare adequate quantities of the chosen forms in high chemical purity. They must recover small quantities of the precious enriched isotopes from the collectors, purify them chemically, and supply them in a variety of chemical forms for

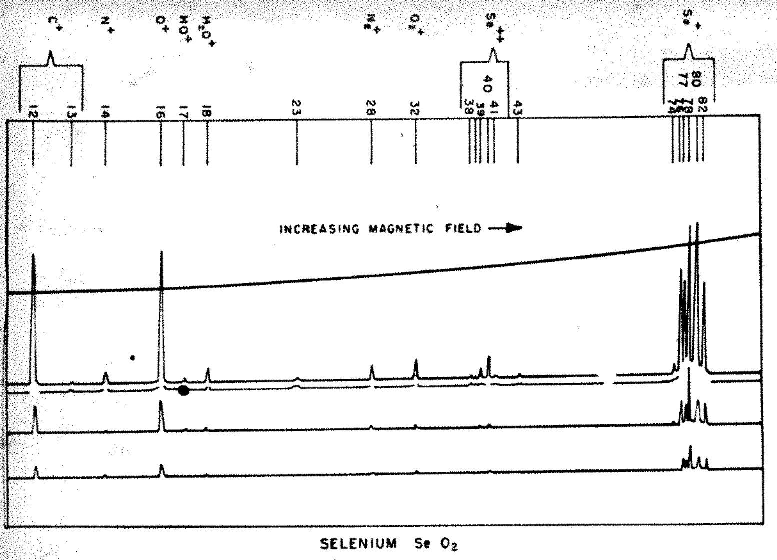


Fig. 3. Ion-beam content in the separation of selenium isotopes using selenium dioxide as the charge material

the user of enriched isotopes. Unusual compounds, pure metals, targets, etc., are often necessary.

The staff of the spectrochemical laboratory must analyse purified isotopes of all the elements so that enriched isotopes of high chemical purity and of reliable analyses are supplied the user. This involves most of the elements of the Periodic Table. An especially valuable discovery has been the adaptation of an iridium filament in the ion source, from which only a few micrograms of an unknown substance are evaporated for mass analysis.

The conversion of the uranium production mass-spectrographs to the separation of isotopes of a wide variety of masses and properties has called on physicists, electronic engineers, mechanical engineers, instrument makers and other craftsmen. The original uranium machines have been improved so extensively that the ion sources and isotope collectors used now resemble only remotely those of a few years ago.

Ion sources for uranium were subjected only to the vapour and ion products of uranium tetrachloride, whereas present ion sources must withstand the action of a wide variety of chemical compounds. The charge material ovens in uranium ion sources were heated to a maximum of 600° C., whereas for some elements now processed more than 2,000° C. is necessary. Only two isotopes of uranium, uranium-235 and 238, were separated, but in the present programme as many as ten isotopes of an element (for example, tin) are collected at one time.

Ionization potentials, process efficiencies, vapour pressures, chemical properties, natural abundances of the isotopes, the difference between adjacent isotopes of an element, and many other factors, influence the behaviour of various elements and compounds in the mass spectrograph.

Production Results

The ion currents registered at the isotope collectors differ widely among the elements. However, collector currents of a hundred milliamperes, representing the ions of all the isotopes of a particular element, are not unusual; these ions originate in a single source.

What production-rate is rep resented by 100 milliamperes of io current ? From elementary theor 1 amp.-hr. of singly charged el mental ion deposits 0·0373 gm atom of that element in the co lector. Hence, 100 m.amp. deposi approximately 26 mgm. per hr. separated lithium isotopes (masse 6 and 7), or 358 mgm. per hr. molybdenum isotopes (masses 9. 94, 95, 96, 97, 98, 100), or 772 mgm per hr. of lead isotopes (masses 20 206, 207, 208), all distribute among the collector pockets amounts proportional to the natural isotopic abundance. It interesting to note that a tot current of 100 m.amp. is equiv lent to about one billion aton moving from source to collect every billionth of a second billion = 1,000,000,000).

The following are the elemen the naturally occurring isotop of which have been successfull enriched in the large Oak Ridge mass spectrographs

Lithium
Boron
Carbon
Magnesium
Silicon
Sulphur
Chlorine
Potassium
Calcium
Titanium
Vanadium
Chromium

Iron
Nickel
Copper
Zinc
Gallium
Germanium
Selenium
Bromine
Rubidium
Strontium
Zirconium
Molybdenum

Ruthenium
Palladium
Silver
Cadmium
Indium
Tin
Antimony
Tellurium
Barium
Lanthanum
Cerium
Neodymium

Samarium
Gadolinium
Hafnium
Tungsten
Rhenium
Iridium
Platinum
Mercury
Thallium
Lead

Only europium, dysprosium, erbium, yttrium an lutetium of the rare earths, the noble gases an osmium have not been processed in the calutrons u to this time. The processing of the rare earths awai the availability of suitable charge material, and th enriching of the noble gas isotopes awaits the develop ment of appropriate isotope collectors. The solutio of both these problems is progressing satisfactoril and there appear to be no insurmountable obstacle

Typical Examples of Separations

As was stated above, all elements processed in th mass spectrograph have their individual characte istics, which result in a wide variety of performance Only a few examples will be given.

Lithium. The enrichment of the lithium isotop was initially tricky. It was difficult to maintai ionization with accelerating potential applied; th addition of a small amount of nitrogen as a 'suppor gas was of benefit. Lithium chloride as the charg material gave the largest ion beams, but its reactio or that of its dissociated components, with the met from which the ion source was fabricated, produc deposits in the ion exit slit of the ionization chambe eventually causing termination of the run. The diss ciation of lithium chloride to $LiCl^+$, Li^+ and Cl^+ io is believed to contribute to this deposition. Th addition of a few per cent lithium metal to th lithium chloride charge eliminated this trouble. A obstacles were overcome, lithium ion beams at th collectors reached several hundred milliampere Because of the large percentage mass differenc lithium-6 and lithium-7 of very high isotopic purit were obtained.

Potassium. Potassium isotopes were enriched, with mphasis on potassium-40. Continued development roduced potassium-40 of greater than 10 per cent otopic purity, its natural starting purity being only ·012 per cent. Later, using a potassium chloride harge which had been previously irradiated in the ile at Chalk River, several milligrams of 22 per cent otassium-40 were obtained. Pile irradiation had ncreased the potassium-40 content to about 0·025 er cent by the $^{39}K(n,\gamma)^{40}K$ reaction.

Iron. Iron isotopes, iron-54 (of 22 per cent natural bundance) and iron-58 (of 0·3 per cent natural bundance) are enriched to provide high-purity non-adioactive isotopes, which are then irradiated in the ile to produce radioactive iron-55 and iron-59 of igh specific activity. Specially purified graphite sotope collectors must be used to eliminate the estruction of isotopic enrichment in the collectors y natural iron contamination in the graphite.

Ruthenium, platinum, iridium and palladium. These lements have been processed, but not without considerable development. The usual compounds of hese elements decompose on heating, so vaporization y ordinary means into the ionization chamber is mpossible. Special techniques of heating the metal s high as 2,500° C. by electron bombardment rovide an abundance of ions, and many milligrams f enriched isotopes have been collected. Even at nly ten milliamperes of ion beam, as much as 0 mgm. of platinum isotopes are collected hourly.

Rare earths. The rare earth elements of atomic umbers 57–71, inclusive, present numerous problems, mong which is the obtaining of several hundred rams of their halides for ion-source charge material. ortunately, a chemical separation of the rare earth lements, using the monazite and gadolinite ores, has rovided adequate charge materials for the isotope eparation of cerium, neodymium, samarium and adolinium. Dysprosium charge material is now on and, and the rarer elements will be available with ontinued efforts.

A tributyl phosphate – nitric acid liquid–liquid ontinuous-column extraction system is employed for eparating the rare earths into their elements, and est conditions are being developed for concentrating ach element. Ion-exchange separation is sometimes sed for final chemical purification of the enriched sotopes.

From the foregoing examples it is seen that most lements present special interesting problems in the nrichment of their isotopes in the mass spectrographs. While successfully enriching the isotopes, considerable research is performed in chemistry and physics as well.

Shipments, Uses and Reports

Isotopes, enriched in the Oak Ridge mass spectrographs, were first supplied to Atomic Energy Commission Laboratories in 1946. In the following year university, industrial and other laboratories were able to obtain these isotopes for research and other uses. By the middle of 1954 more than two thousand shipments had been made, and shipments continue at the average rate of one shipment a day. Although these isotopes have been available only on loan to domestic users, a sales programme abroad has now been inaugurated.

New and valuable scientific data on such phenomena as nuclear spins, magnetic moments, hyperfine spectra, isotope shifts, nuclear energy-levels, decay patterns, neutron cross-sections, studies linked with cyclotron and other accelerator bombardments, superconductivity, beta spectroscopy, etc., have been obtained through the use of enriched isotopes.

Several enriched stable isotopes are used in the pile on a recurrent basis to produce useful radioactive isotopes. Other studies show that it is technically feasible and economically advantageous to use certain enriched stable isotopes in the cyclotron to produce radioactive isotopes not now available; initial production has begun.

Although most of these calutron-enriched isotopes are non-radioactive, the enrichment of such radioactive isotopes as beryllium-10, potassium-40, samarium-147 and others has made it possible to clarify their disintegration properties.

Not all the benefits of this stable isotope programme are in the use of the isotope products. Developments in gas discharge, ion sources, mass spectrometry, optical spectroscopy and inorganic chemistry have not only assisted in the enrichment of stable isotopes themselves, but also these developments have contributed to other atomic energy activities, particularly in the reactor field.

Many reports have been written on research made possible by having available enriched stable isotopes. In the *Physical Review* since 1946 more than four hundred such technical papers and abstracts have been published. These unclassified papers have sprung from about forty per cent of all shipments made to users outside the Atomic Energy Commission. This represents about one research report for every two shipments. No information is available on research done with the other sixty per cent of all shipments going into strictly Atomic Energy Commission studies.

The work described in this article results from the co-operative efforts of all personnel in the Stable Isotope Research and Production Division, Oak Ridge National Laboratory, and was carried out for the United States Atomic Energy Commission by Carbide and Carbon Chemicals Company, a division of the Union Carbide and Carbon Corporation.

PRODUCTION OF ELECTROMAGNETICALLY ENRICHED STABLE ISOTOPES AT HARWELL

By DRS. W. D. ALLEN, R. H. DAWTON, M. L. SMITH and P. C. THONEMANN

General Physics Division, Atomic Energy Research Establishment, Harwell, Berks

History of the British Project

IN 1946, when the U.S. Atomic Energy Commission calutrons had already been producing stable isotopes for a year, it was decided to provide facilities at the Atomic Energy Research Establishment, Harwell, for the supply of electromagnetically enriched stable isotopes to nuclear research workers both at Harwell and in British universities. Two 180° machines were built[1], the smaller prototype for the production of nuclear targets by direct deposition from the beam on to suitable backings, and the

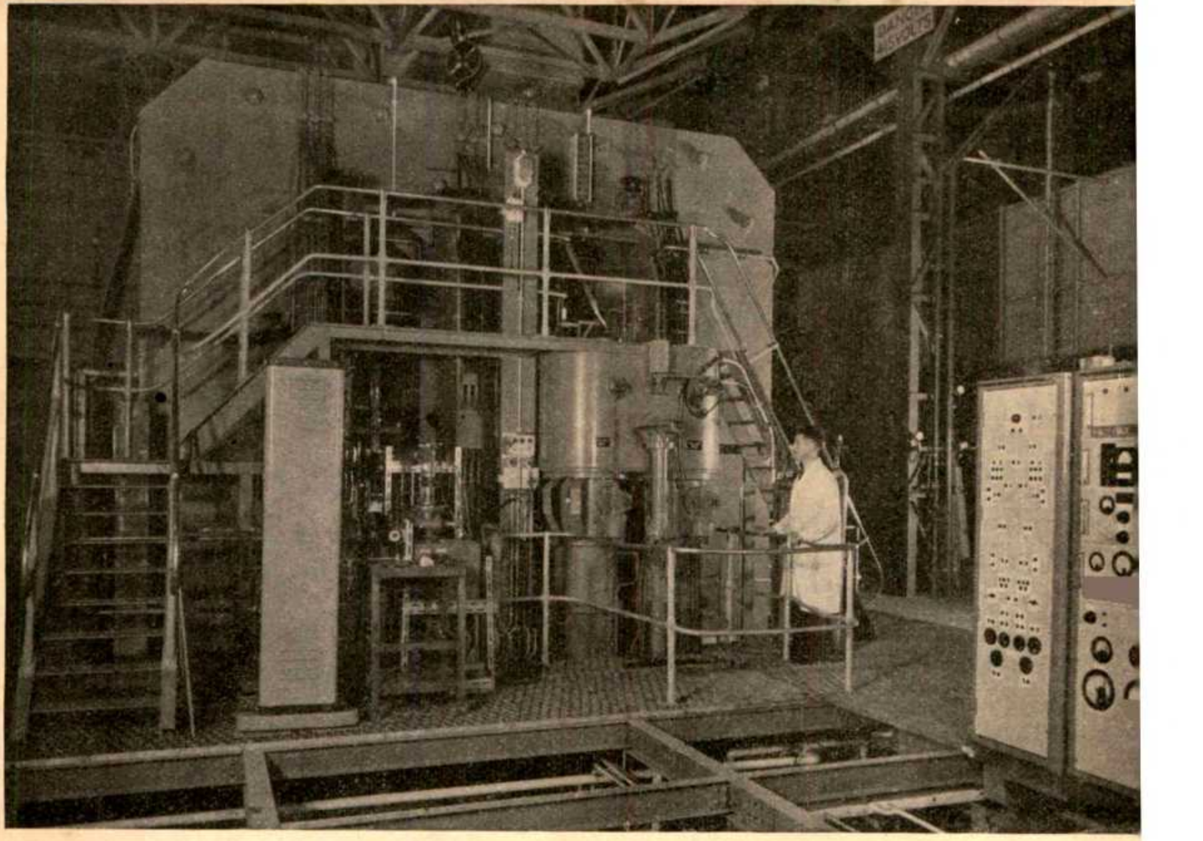


Fig. 1. General view of the large electromagnetic separator at Harwell

larger for the separation of gram-quantities of enriched isotopes.

The smaller machine started operation in 1948, and though of rather limited resolution was very useful for making nuclear targets of the lighter elements. Recently this machine was rebuilt as a 2-ft. radius 60°-sector separator for experimental work on ion sources, for separations of the rarer elements, where the source materials are expensive, and for separation of slightly active materials. This facility will be available shortly.

Early in 1950, the larger separator, which is a vertical 180°-machine of 2-ft. radius and somewhat similar in general layout to an early American machine at Berkeley, was started up. Subsequent developments were largely independent of the U.S. effort and there were numerous detailed departures from American practice; for example, in the extensive use of graphite in the source units, design of receivers, and the use of tungsten heaters for source temperatures up to 1,000° C. The machine is now being run on a production basis with shift operators.

Present Production

The outputs and enrichments obtained with the large Harwell separator are broadly similar to the results reported by the Oak Ridge workers for the smaller of their machines, and it is unnecessary here to add to the very complete account of separation experiences given in the preceding article. Owing, however, to the later British start, the inventory is smaller, though thirty-seven elements have been separated and stocks are available of most of them. Principally the lag is in the separation of the elements requiring exceptionally high temperatures, the pa ladium and platinum groups; mercury, whi requires special refrigeration arrangements; a certain elements which are not available in quanti as source materials such as rhenium and hafnium. start has been made on the rare earths, the ceriu and neodymium isotopes being already available.

Applications

Much valuable work has been done and publish by British Commonwealth and European worke with stable isotopes from Harwell. Reference ma particularly be made to the superconductivity studi on tin[2], the hyperfine spectral work at Oxford, and

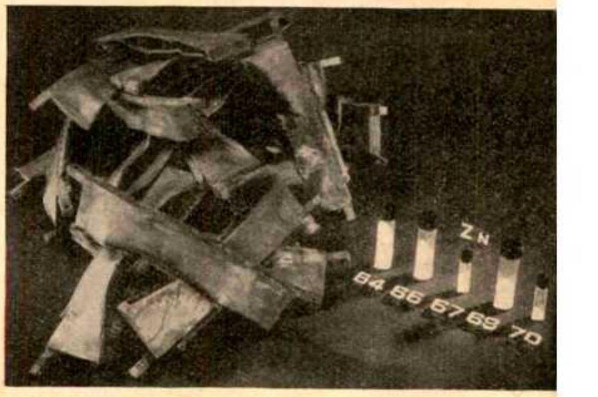


Fig. 2. Chemical processing of zinc isotopes. Photograph of the collectors used (after processing) and the bulk of enriched product as zinc oxide

umber of reaction studies too numerous to list here. arge amounts of calcium-44, iron-58 and chromium-0 have also been supplied for the production by pile radiation of radioactive tracers which have been sed in a great variety of researches So far, 570 eparate consignments or targets, ranging in size om micrograms of calcium-46 to 30 gm of iron-56, ave been dispatched to workers at Harwell and in uropean and Commonwealth laboratories The utput is now about two hundred consignments a ear and rising steadily

Particular emphasis has been laid by the Harwell roduction group on the provision of targets for uclear bombardment from the stock of stable sotopes It was found in early work that targets of lements heavier than magnesium could not be made y direct deposition in the separator because of putter, and so it was necessary to use a secondary rocedure Such procedures have the advantage, oreover, of starting with a definite amount of aterial of known purity, providing the most fficient utilization of the stocks, and being very onvenient for the users, who can request targets to uit their most varied requirements and obtain elivery within a few days For preparation of these argets a range of techniques has been adopted ncluding vacuum evaporation, electroplating, painting and thermal cracking, while special attention is aid to the recovery of residues without contamination In the course of development of these methods, useful stock of isotopic targets has also been uilt up

Some work has also been done on the preparation f gas targets by direct bombardment on to metallic oils, and by this means targets containing oxygen, itrogen or the rare gases have been made for reaction udies, while following Koch's[3] technique krypton-84 as been recovered from foils for use in spectrographic ischarge lamps

The British Thomson-Houston Co, Ltd, and the etropolitan-Vickers Electrical Co, Ltd, constructed he large separator, members of the Electromagnetic eparator Group and the Engineering Services ivision of this Establishment are responsible for peration and continuing development, while the uality of the isotopically enriched samples is hecked by the Mass Spectrographic and Spectrochemical Groups. Sales are made through the sotope Division

Allen, W D, *Nature*, **168**, 451 (1951)
Nature, **166**, 1071 (1950)
Koch, J, *Nature*, **161**, 566 (1948)

JOHN RAY, F.R.S. (1627–1705)

By JOAN M. EYLES

JOHN RAY, the seventeenth-century naturalist, has received more attention from the historians f science than many of his contemporaries The ay Society has published a memoir and two volumes f his correspondence, and his life and writings have ecently been treated in great detail by Dr. C E aven, to whom students of Ray and his times will lways be indebted In addition, a bibliography of is works, by Dr Geoffrey Keynes, appeared in 1951 t might seem, therefore, that little new remains to e said in this article, which commemorates the two hundred and fiftieth anniversary of his death, on January 17, 1705 Recently, however, attention has been directed to the influence of Puritanism on the development of science in the seventeenth century[1], and the occasion provides an opportunity for outlining Ray's career in this setting, as well as to offer an amendment to Dr Raven's conclusion that in geology Ray's outlook was "far in advance of all his British contemporaries"

John, the son of Roger Ray, blacksmith, of Black Notley in Essex, received his early education at the little grammar school of Braintree, two miles from his home and thirty miles south-east of the University of Cambridge At that time the school was held in what is now part of the church Ray's numerous letters throw remarkably little light on his private life, but those early grammar school days are recalled in a few dry lines in a letter he wrote to John Aubrey many years later "Neither is y^r observation universally true that the sons of labourers and rusticks are more dull and indocile than those of gentlemen and tradesmen but perchance the advantage I had of my contemporaries may rather be owing to my industry than natural parts" Ray's career was certainly built on something more than industry alone

In 1644, as a sixteen-year-old lad, he entered the University of Cambridge, supported, Dr Raven surmises, by a local charity intended to maintain "two or three hopeful poor scholars . . being also of sober and Christian conversation" At that time the Parliamentary forces had already gained the ascendency in their struggle with Charles I, and Ray's arrival at the University coincided with a period of considerable change Many Fellows, including a dozen heads of colleges who had found themselves unable to accept the Solemn League and Covenant, were being expelled from their offices During the ensuing Presbyterian regime, religion became something stern and colourless, the parish churches were stripped of their ornaments, and the prayer book and feast-days, including Christmas and Easter, were abolished

John Ray himself, however, prospered, and in 1649 was elected a Fellow of Trinity College Two years later he was accepting the usual responsibilities of a young Fellow, and acting in successive years as lecturer in Greek, in humanities and in mathematics It is true his health was not very robust An illness about the year 1650 had obliged him to rest for a while from serious study and take more fresh air, a pursuit that had directed his attention to the beauties of the Cambridge meadows, and set him to studying botany He was unable to find anyone in Cambridge who could instruct him in the subject, so turned to such books as were available, and began to collect plants for 'a little garden by his chamber"

In 1655 Ray's father died, and soon after, Ray seems to have arranged for the building of a house called Dewlands, at Black Notley, in which his widowed mother lived until her death in 1679. About this time he began to hold various College offices, and his action in building Dewlands seems that of a man who felt reasonably secure financially. He was not yet ordained, although in normal times it was required of most Fellows With the return of the bishops in 1660, this was to become a pressing question with him His earliest surviving letter, written in January 1659, indicates his views at that time "My present condition is such that I must of necessity enter into orders, or else live at great uncertainties, and expose myself to the mercy of men for my livelyhood and continuance here I am not resolved to enter into orders, if so be I stay here, but rather the contrary, it consisting not with those designes which I intend to pursue Now, if I shall bid farewell to my beloved and pleasant studies and employments, and give myself up to the priesthood, and take to the study of that which they call divinity, I thinke it were the best way to throw myself into the country, and make such provision for this world as other men doe, and make it my business to execute the priest's office" Ray was at this time engaged in preparing his catalogue of Cambridge plants, and the advantage of a country living to one so devoted to botanical pursuits is obvious, but what he had in mind when he wrote of staying in Cambridge, but not taking orders, is not clear Perhaps he had hopes of becoming a "Physic Fellow" in one of the colleges, which would have exempted him from taking orders There is little information regarding the teaching of medicine in Cambridge at that time, although several of Ray's contemporaries became physicians There had been a regius professor of physic in Cambridge since 1540, and in Ray's time this was Sir Francis Glisson, a distinguished physician, but so far as Cambridge was concerned a notable absentee He had left Cambridge at the outbreak of the Civil War and seldom visited it

In May 1660, Charles II was welcomed back to England by a people weary of internal wars and religious dissension Some measure of toleration and individual liberty was promised and expected, but the Puritans, many of whom were ministers of the Church, were soon to be disappointed We get a glimpse of the state of affairs from a letter written by Ray in September 1660 "Dr Ferne, who is made master of this colledge came down hither about the beginning of August, with 14 or 15 of the old gang . They have brought all things here as they were in 1641 viz, services morning and evening, surplice Sundayes and holydays, and their eves, organs, bowing, going bare, feasting nights" This gives a clear indication of Ray's Puritan outlook He wrote in the same letter "I have long since come to two resolutions, namely, no promise of conformity, and no orders". He must have changed his mind, or been over-persuaded by friends, for three months later he was ordained in London by the Bishop of Lincoln After this, in three different letters written in June and October of the following year, he stated his intention of leaving the College. He seems to have considered a living in Westmorland but rejected it, partly, he says, because "I find the yearly value to be lesse than it was at first represented"

In May of 1662 the Act of Uniformity received the Royal Assent and Ray knew his days at Cambridge were numbered The Act required conformity, and a declaration that the Solemn League and Covenant had been an unlawful oath, and it was obligatory for those teaching in colleges and in holy orders "I have already taken so many oathes & subscriptions as have taught me to disgust such pills", wrote Ray in 1662, and in August, "I shall now cast myselfe upon Providence and good friends Liberty is a sweet thing. I am hampered enough already, indeed more than I would have been had I foreseen this"

On August 24, St Bartholomew's Day, some eighteen hundred clergymen were ejected from their benefices for non-conformity, and Ray, who had quietly absented himself from Cambridge at the time, ceased to hold his fellowship.

In his hope for support and encouragement frc his friends, Ray was not disappointed In particul Francis Willughby, 'virtuoso' and naturalist, a form student with whom he had already made t botanical tours, rallied to his aid In 1663 Ra Willughby and two others set off on a tour of t Continent, and to gather materials for a gene natural history It is worthy of note that t universities which they first visited—Leyden, Utrec and Heidelberg—were all strongly Calvinist Willughby returned to England a year later, b Ray and another friend and former student, Phi Skippon, remained abroad until 1666 Shortly af his return, Ray made a botanical tour in Cambrid shire and Lincolnshire with Dr Martin Lister, w made some notes about it beginning "Mr Wray, M Dent & I went out a simpling"[2]

In 1667 Ray was elected to the Royal Socie and during the next five years spent much of time travelling about England, and at interv resided at Middleton, Willughby's home in Warwic shire This nomadic life was brought to an abru halt by the sudden and unexpected death Willughby, then only thirty-seven years of a Willughby, however, had looked to the future of friend, and left him an annuity of £60, which w later increased to £72 by his son, Thomas Willughb This was a generous allowance for the time Accordi to the tables of Gregory King[3], the average yea income of "lesser clergymen" in 1688 was £50, a that of "eminent clergymen" £72

Ray married in 1673, and for a few years continu to live in or near Middleton, working on Willughb collections and notes In 1679, when his mother die he was living in Essex again, and he and his w then moved into Dewlands, the house he had bu and in which he was to reside until his death. F mother's will, drawn up in Ray's neat hand in 16 shows that the blacksmith's forge was still in t family, for "all tools and utensils belonging to t shop, excepting the iron" were left to her son-in-la John Tabor, and the rest of her goods and chatte with the exception of 20*s* to the poor of Black Notl were to be divided between her son John and h grandchild Sarah Tabor[4]

From now on Ray devoted himself to the prepa tion of his botanical works, as well as the zoologi works which appeared under the name of Willughb though Dr Raven has shown they owed much Ray's own researches In 1688 an event of co siderable importance to the nation, and particula to the nonconformists, took place. James II w replaced on the throne by the Protestants Willia and Mary In 1689 the Act of Toleration was pass and this freer atmosphere was praised by Ray in Latin preface to his "Synopsis Methodica Stirpi Britannicarum", published in 1690. "Supersti has been overthrown Pure and reformed religion honoured," he wrote, and in the following year published a work entitled "The Wisdom of G Manifested in the Works of the Creation", compos largely of sermons he had delivered in Cambri more than thirty years before This was followed 1692 by a more specialized work, "Miscellane Discourses concerning the Dissolution and Chan of the World". The latter contained Ray's geologi observations and conclusions, and in later editions w entitled "Three Physico-Theological Discourses".

Ray, as Dr Raven himself states, could go on w his natural history without consciously challeng the historicity of Genesis, but in geology he enter he arena of conflict Comparisons are often unfair and ometimes invidious , but Dr Raven has stated that Ray's outlook in geology was much ahead of all his British contemporaries These contemporaries were Robert Hooke, Dr Martin Lister, Robert Plot of Oxford, and two men of a younger generation, Edward Lhwyd and John Woodward They all discussed the nature and origin of fossils (Lister and Lhwyd in letters to Ray), and it is to this point that Dr Raven gives most attention Hooke, in time as well as in accurate and penetrating commentary, takes precedence of them all, for his statement about fossils in "Micrographia" (1665), though short, is to the point Some account of Hooke's geological ideas, and the period to which they rightly belong, has been given by W N Edwards[5] and by A P Rossiter[6] Hooke's geological observations, in addition to those in his "Micrographia", are found in his Cutlerian Lecture, "De Potentia Restitutiva" (1678) and in his "Posthumous Works" (1705) The latter includes the text of two discourses delivered to the Royal Society between June 17, 1667, and September 1668 In none of these does Hooke waver from his view that fossils were genuine remains of once living creatures Ray, on the other hand, felt obliged (as he wrote in a letter to Lhwyd in November 1690) "to settle in a middle opinion, that some are of one kind, some of another" Lhwyd answered in the same month and in the same vein "I find in myself no sufficient ability or confidence to maintain either opinion" It is not denied, and there is abundant evidence, that Ray was anxious to believe that fossils were remains of once living things , but he had a fundamental reason for this, made clear in some pages (unnumbered but following p 162) first inserted in the second edition of the "Discourses" (1693) "For," he wrote, "if we adhere to their Opinions who hold them [that is, the fossils] to have been original Productions of Nature, in imitation only of the Shells and Bones of Fishes We put a Weapon into the Atheists hands" This weapon, which Ray discusses at some length, was the argument that if fossils were mere sports of Nature, produced without reason or function, then living animals, too, could be produced without "Counsel or Design". Such an argument, difficult for the modern reader to appreciate, struck at the very core of Ray's creed of divine design in Nature For this reason, above all others, he was constrained to support the view that fossils had once been living things

Two arguments against this, however, Ray had great difficulty in answering One, which concerned the Deluge, will not be discussed here , the other was the fixity of species That species might disappear he had thought "highly improbable" , but many of the fossils then being found could not be matched with living forms, and he could only hazard "that there may be some of them remaining some where or other in the Seas" Hooke had accepted the implication of extinct species , but it was this implication, more than anything else, that seems to have driven Ray to decide finally in favour of an inorganic origin for fossils Dr Raven has called this a recantation , but it was rather a reluctant conclusion from the evidence interpreted in the light of Ray's beliefs, evidence that had steadily accumulated as more and more ammonites and Coal Measure plants, which had no known modern equivalent, were discovered by the untiring efforts of Lhwyd, Woodward and other collectors We can sympathize with Ray in his difficulty , but we must not overlook the clear thinking and bold imagination of Hooke. Thus, there seems no room for doubt that it is Hooke rather than Ray who deserves Dr Raven's encomium It must be stressed, however, that the advances in geology were made not by the theorists but by field-workers The latter include John Woodward, whose theories were weak, but who insisted on the importance of accurate field records

The last fifteen years of Ray's life were spent in constant pain and illness, but his industry never slackened He was indeed, as H B de Saussure wrote in 1779, "le Naturaliste le plus universel que l'Angleterre ait produit"

---

[1] See especially, Merton, R K , "Science, Technology and Society in Seventeenth Century England", *Osiris*, 4, 360, (1938)

[2] Bodleian MS , S C 25268, ff 421–441 quoted from Goulding, R W , "Martin Lister, M D , F R S ", Rep for 1900 of Architect and Archæol. Soc of the Counties of Lincoln and Nottingham

[3] Quoted from "English Social History", by G M Trevelyan

[4] Original will at Somerset House, Comm Ct Lond (E and H), 1679

[5] Edwards, W N , "Robert Hooke as Geologist and Evolutionist", *Nature*, 137, 96 and 455 (1936)

[6] Rossiter, A P , "The First English Geologist", *Durham Univ J* , 29, 172 (1935)

OBITUARIES

Prof H S Carslaw

THE death occurred on November 11 at the age of eighty-four of Horatio Scott Carslaw, emeritus professor in the University of Sydney, and Fellow of Emmanuel College, Cambridge, professor of mathematics in the University of Sydney during 1903–35 Carslaw held the degrees of doctor of science of Glasgow and Cambridge, and the honorary degree of doctor of laws of Glasgow

Carslaw served the University of Sydney through a period of great expansion He had precisely that balance of qualities which best fit a man to raise a small department, not very different from a 'sixth form', to a university school of mathematics with a world-wide reputation for its published work and for the quality of its graduates He had a vigorous personality of the type around which legends collect, he was a mathematical scholar of distinction with a gift for clear exposition, and he was enthusiastic in his mathematics and aroused enthusiasm in his students

During his tenure of the chair, the University of Sydney grew from a family affair of a few hundred students to a complex organism of four thousand students in ten faculties In particular, this period saw the rise of the Faculties of Science and Engineering In large measure the high standing of Sydney engineering graduates was due to Carslaw's influence on the shape of the course His locally famous 'little book' bears the title "An Introduction to the Infinitesimal Calculus Notes for the Use of Science and Engineering Students". His first- and second-year pass courses had very much the needs of these students in mind. The book is one of those that a lecturer likes to use as a basis for a lecture course , the text is little more than a record of leading results, there are plenty of examples, and the lecturer has scope for his own elaboration and development of the subject

Carslaw played a large part in the development of the State (New South Wales) secondary education system, in particular in the formulation of the mathematics syllabus and its examination at the Leaving Certificate Between 1911 and 1916 he published a series of articles and reports, under such titles as "The Teaching of Elementary Mathematics" and "Secondary Education in Australia", which have done much to give direction and purpose to mathematical teaching in the State right up to the present time

Carslaw's interests in mathematics were wide, as a list of his principal works shows "An Introduction to the Theory of Fourier Series and Integrals and the Mathematical Theory of the Conduction of Heat", first published in 1906 and rewritten and published as two separate volumes in 1921, "Plane Trigonometry" (1909), "Elements of Non-Euclidean Plane Geometry and Trigonometry" (1916), and "Operational Methods in Applied Mathematics" (1948, with J. C Jaeger) Each of these contains work which is Carslaw's own contribution to the subject The earlier works were many times reprinted and were standard text-books for more than a quarter of a century The "Fourier Series" and the "Conduction" were translated into Japanese, and the "Conduction" was reprinted and widely circulated in the United States during the Second World War

From 1916 onwards he published from time to time articles in the *Mathematical Gazette* and elsewhere on "Progressive Income Tax", and was consulted by the Commonwealth Treasury on the formulæ to be adopted, the aim of the formulæ being to give a continuous increase of rate of tax over quite a long range of incomes, such formulæ were in use until quite recently.

After retiring from the chair of mathematics in Sydney in 1935, Carslaw spent all his time on his small orchard property at Burradoo, eighty miles from the University, and only rarely went to the city But his interest in mathematics continued unabated, until within the past three years failing sight made it impossible for him to continue After the War, while in his late seventies, he had several years of fruitful collaboration with one of his students of twenty years earlier, now Prof J C Jaeger The fruits of this collaboration were the revised third edition of the "Conduction", and the "Operational Methods" mentioned above

In 1907 Carslaw married Ethel Maude, the daughter of Sir William Clark, but she died within the year Thereafter, Carslaw took little part in the social life of the University of Sydney, but he contributed with his characteristic vigour and vivacity to all other phases of University activity T G Room

Sir Frederick McMaster

Sir Frederick Duncan McMaster died at his home at Dalkeith Station, Cassilis, N S W, on November 28 He was one of Australia's best-known pastoralists and a prominent studmaster One of his main interests was breeding merino sheep, and he gradually built up the world-famous Dalkeith Stud Sheep from this stud won many prizes in competition, and at one time a ram from this stud held the world's record for the greatest price

Sir Frederick was interested in and supported many plans for the improvement of Australia's pastoral industry He was always anxious and willing to help the small man On one occasion he presented the Government with five hundred merino rams valued at £4,000 for distribution to small-scale farmers who had been badly affected by the depression He was also interested in beef-cattle breeding His success was well recognized by many prizes at the Sydney Royal Show

In 1929 the Prime Minister made an appeal fo public support for research into Australian primar industries Sir Frederick responded by the presentation of £20,000 for the erection of a laboratory fo the investigation of animal health problems Thi laboratory, known as the McMaster Animal Healt Laboratory, was erected for the Commonwealt Council for Scientific and Industrial Research at th University of Sydney A great deal of invaluabl research has been done at this laboratory When i became known to Sir Frederick in recent months tha the McMaster Laboratory was in urgent need o additional space, he spontaneously instructed hi solicitors to arrange for Commonwealth bonds to th value of £52,800 to be made available to the Universit of Sydney for the erection of a wing to the Laboratory

Sir Frederick took a keen interest in research particularly in agriculture He was a member of th N S W State Advisory Committee of the Commonwealth Scientific and Industrial Research Organization for many years He provided facilities on hi own properties for scientists to carry out field-work and leased 2,000 acres of Hinchinbrook Estate t assist scientific research He was a keen observe and co-operated with the Meteorological Office i obtaining and keeping complete meteorologica records He was a prominent member of the Roya Agricultural Society of New South Wales and als an honorary life member of the Royal Agricultura Society of England

Sir Frederick was born in 1873 and was educate at the Sydney Grammar School In 1934 he wa created a knight bachelor in recognition of his grea services By his death, Australia has lost a grea pastoralist, a keen supporter of scientific work, an a generous benefactor J. R A McMillan

NEWS and VIEWS

Sunspots of the New Cycle

The Astronomer Royal reports the appearance o two sunspots that are the first sizable spots of th new eleven-year cycle Particulars of these are a follows

Date on sun's disk	Central meridian passage (U T)	Latitude	Are
Jan 2–14	Jan 8 1	20° N	10
Jan 7–19	Jan 13 1	36° N	80

The areas were measured on January 9, the previou days having been overcast The unit of area is one millionth of the sun's hemisphere In addition to th above two spots, an earlier one (probably of comparable size) was observed at Edinburgh on Decembe 30 during the overcast period at Herstmonceux Thi spot group, in latitude 24° south, must have develope suddenly between December 28 and 30, and woul have passed off the sun's disk on January 5

The sunspot cycle, with its great peak of activit in 1947, presumably ended just before the middle o 1954 There has been the characteristic overlap i latitude of the old-cycle spots petering out i equatorial regions and the increasing incidence of th small new-cycle spots in latitude 20°–40° An remaining doubt concerning the epoch of minimu significant to 1954 4 is now removed by th appearance of these definite spot groups, indicatin that the new eleven-year cycle has now definitel begun.

illiam Sharp (1805–96)

To his medical colleagues, William Sharp, who was rn at Armley, near Leeds, one hundred and fifty ars ago, on January 21, 1805, was known as a gorous champion of homœopathy, but he is also membered as a pioneer of science teaching in public hools in Britain and also of the local museum lucated at Wakefield Grammar School and at estminster School, he was articled to an uncle, a adford surgeon, in 1821 After attending the nited Borough Hospitals in London, he was licensed the Society of Apothecaries in 1826 and became member of the College of Surgeons of England in e following year In 1829 he was elected surgeon the Bradford Infirmary, and succeeding his uncle 1833, he had one of the largest general practices the West Riding of Yorkshire He founded the adford Philosophical Society and served as its st president At the Birmingham meeting of the itish Association in 1839, he advocated the estab- hment of local museums for the display of exhibits particular interest to the district Shortly after- rds he was elected a Fellow of the Royal Society hile in practice at Hull, he lectured on chemistry the Hull and East Riding School of Medicine, and terwards was responsible for the introduction of ence teaching at Rugby School—an example soon lowed by other public schools Sharp wrote some ty tracts on homœopathy Stressing the opposite- tions of large and small doses of the same drug, tried to reconcile homœopathic and allopathic ching One of his best-known works was "Thera- utics founded upon Organopathy and Antipraxy" 386) Sharp received the M D from the Archbishop Canterbury in 1856 and died at Llandudno on ril 10, 1896, aged ninety-one

ief Librarian of the Commonwealth Scientific and Industrial Research Organization

Miss E L Archer, chief librarian of the Common- alth Scientific and Industrial Research Organiza- n, Melbourne, has retired Miss Archer has had a nger association with the Organization and its decessors than any other member of the staff e has built up the library system of the Organ- tion over a period of thirty years, and her re- nsibility extends beyond the management of the rary at head office to include the supervision of re than thirty divisional and sectional libraries tributed through every State of the Common- alth of Australia She has done much to raise the tus of librarians in Australia and to gain recog- ion for library work as a specialist profession, and s the first woman federal president of the Aus- lian Institute of Librarians in 1948 Miss Archer s born and educated in Melbourne, and holds the gree of M Sc of the University of Melbourne with nours in botany She made a special study of the of the Universal Decimal Classification and intro- ced it into the libraries for which she was responsible er a visit to Europe, including Great Britain, ing 1936

ding in Plant and Animal Taxonomics

Two meetings have been held at the Chemical- ological Coordination Center, National Research uncil, Washington, D C, "to explore the poss- lity and desirability of developing a unified system coding plant and animal taxonomic entities" fortunately, no samples of proposed systems of coding are given Apparently the idea is that every taxon shall be given a 'code number' built up of figures indicating designation, ordinal relationship, and description Since taxonomy is dynamic, not static, with, one hopes, its methods and results constantly progressing, it is difficult to envisage a code that would not require frequent revision However, supplementary data may clear up some of the doubts that arise when one envisages an elaborate scheme in practice Taxonomists wishing for further information should apply to Dr G Congdon Wood, Chemical-Biological Coordination Center, National Research Council, 2101 Constitution Avenue, N W, Washington 25, D C, U S A An outline scheme for taxonomic coding was given, apparently quite independently of the meetings referred to above, in *Chronica Botanica*, 12, 211 (1951)

Stalk Borers of the Tropics

The stalk borers of graminaceous crops in the tropics are chiefly lepidopterous caterpillars In the aggregate they levy a heavy toll on the world's food supply, but because their action is insidious, occurring year after year to a varying extent, but without such spectacular effects as the locust may bring about, their importance is often overlooked and effective action is seldom taken Indeed, in most regions there is no reliable assessment of the damage they cause Moreover, the prior attention of entomologists has usually been given to insect pests of plantation crops in which the prospects of early control are generally more promising At the present day two factors are tending to remove this indifference the insistent demand for increasing the food production of the world, and the development of synthetic insecticides which may prove applicable in tropical peasant agriculture It is therefore timely that Dr W P Jepson should have produced a "Critical Review of the World Literature on the Lepidopterous Stalk Borers of Tropical Graminaceous Crops" (pp vi+127. London Commonwealth Institute of Entomology, 1954, 15*s*) Here, for the first time, all the available information on this subject has been brought together

Archæology of Deneholes

The "Proceedings" for 1954 of the Croydon Natural History and Scientific Society contains interesting articles on deneholes and on Croydon itself Deneholes are excavations in underlying chalk reached by vertical shafts through the overload. They often consist of a number of chambers, and the excavations were carefully and scientifically done The vertical shafts—sometimes 30–40 ft deep—can be dangerous and so have frequently been plugged It sometimes happens that the plugs themselves collapse into the underlying cave, as has recently occurred at Waddon This gave an opportunity for investigation before the plug had to be reinstated. The age of the deneholes seems to be pre-Roman, and they are probably of the Iron Age Many explanations have been given as to why they were made, but none is satisfactory Underground granaries or stores have been suggested, or pits for obtaining chalk for agriculture, but, if the latter explanation be the correct one, why have they been so carefully made? Drainage sumps, places of worship, underground dwellings and secret refuges, or burial places have all been suggested from time to time It would seem clear, however, that some connexion must exist between these artificial caves and the earth-houses of northern Scotland But unfortunately we do not really know why these latter were made, either

Making and Measuring Gauges

DURING the Second World War a booklet dealing with the making and measuring of gauges was prepared by the staff of the National Physical Laboratory, Teddington, as a war-time aid to firms who were entering the field of gauge-making for the first time, and a new and revised edition of this booklet has now been issued as No 5 in the series of "Notes on Applied Science" under the title of "Gauge Making and Measuring" (pp 79+1 plate London H M S O , 1954 , 3*s* net) The Notes touch upon both the manufacture and measurement of gauges and, in addition, include descriptions of measuring equipment suitable for this class of work. Only the simpler types of plain and form gauges are considered, as screw gauges are adequately dealt with in No 1 of the series. Much information which should be already familiar to experienced gauge-makers is included , but several novel topics are also discussed. The contents consist of four parts. Part 1, which is of a general and introductory nature, refers to the general requirements of gauges as to marking, dimensions, hardness and finish in accordance with British Standard specifications The serious errors that can arise in the measurement of gauges as a result of thermal expansion are particularly emphasized Part 2 deals with the selection of suitable steel for gauges and with the detailed techniques for machining, hardening, stabilizing and grinding the blanks, and with other workshop methods, some novel, involved in gauge-making Parts 3 and 4 are devoted to measuring apparatus commonly used in gauge-making and describe bench micrometers, vertical comparators and using light in measurement. "Gauge Making and Measuring" is a valuable addition to the literature on metrology and should be of particular assistance not only to gauge-makers but also as a text-book for students who are studying metrology as a subject in the National Certificate Examinations

Chemical Abstracts: New Greek Journal

THE Centre of Bibliographical Investigation in Athens has begun to publish a monthly abstract journal, *Chemical Research*, dealing with pure and applied chemistry This contains abstracts in Greek of papers published in journals of all countries , but there is an appendix, which in the copy received is in English, French and Italian, of abstracts of papers published in Greece This appendix will serve to direct attention to publications of Greek chemists, and, since one of the abstracts is of a doctoral thesis of the University of Athens, it is likely to refer to publications which could otherwise be missed The journal is published from 44 Charocopou Street, Kallithea, Athens

Earthquakes during May–September 1954

FORTY-SEVEN earthquakes having instrumental magnitude 6 or greater occurred during May–September 1954 The greatest (magnitude 7¼) occurred on September 17 in the region of the Fiji Islands The earthquake with the deepest focus (600 km) also occurred in the Fiji Islands region on September 15. Earthquakes were reported as having occurred in Europe as follows Greece and adjacent countries (5), Switzerland (7), Spain (5), Jan Mayen Island (3), Germany (1), Belgium (1) and Norway (1).

Textile Institute: Medal Awards

THE following awards have been announced by
Textile Institute the Institute Medal, awarded
distinguished services to the textile industry
general and to the Institute in particular, to Mr
Crossley, managing director of the Yorkshire Dye
and Proofing Company, Ltd , Middleton, Lan
and to Dr P W Cunliffe, research manager of
British Cotton and Wool Dyers' Association, Lt
the Institute Service Medal, awarded in recognit
of valuable services to the Textile Institute, to
E J D Poole, senior principal technical officer
the Wool Industries Research Association , Mr
Morris, textile chemist with Allied Colloids (Ma
facturing) Co , Ltd , and Mr J R S Goodall,
Stockport

N.Z National Research Fellowships (1955)

THE Minister of Scientific and Industrial Resear
New Zealand, has awarded the four National Resea
Fellowships to be taken up during 1955 as follow
Dr H C. Clark, junior lecturer in the Chemis
Department, Auckland University College, who
carry out research at the University of Cambridg
Mr H V Brewerton, a chemist at the Domin
Laboratory (N Z Department of Scientific a
Industrial Research) at Wellington, who will work
the chemistry of the extractives of New Zeala
timbers at the University of Nottingham , Mr P
Fitzgerald, a plant breeder at the Crop Resear
Division of the N Z Department of Scientific a
Industrial Research, who will work in the Genet
Department, University of Adelaide , Mr J
Lovis, of the Department of Botany, University
Leeds, who will work in Canterbury Univers
College These Fellowships are offered annually
suitable applicants with postgraduate experience
scientific research to enable them to study at N
Zealand or overseas institutions Each Fellows
has a value of £600 a year, an additional £100 a y
being paid to a married man Grants of up to
for books, fees, etc , and up to £150 for travel
also paid The tenure of a Fellowship is for one y
with provision for an extension by a further y
where such extension is justified.

Conference on Mass Spectrometry

THE Third Annual Conference on Mass Spect
metry under the sponsorship of Committee *E*-14
the American Society for Testing Materials will
held during May 23–27 at the Mark Hopkins Ho
in San Francisco, California All aspects of
theory and application of mass spectrometry will
covered Titles of papers should be submitted
February 15 to Mr William Priestley, jun , Stand
Oil Development Co , Box 121, Linden, New Jers
There will also be an exhibit of mass spectrome
equipment, information about which can be obtai
from Dr J. G Hutton, General Electric Co , 1 R
Road, Schenectady, New York

Colonial Service: Recent Appointments

THE following appointments have recently b
made in the Colonial Service J S Blackl
(agricultural officer, Sarawak), agricultural offi
Northern Rhodesia , L H Brown (agricultu
officer, Kenya), provincial agricultural officer, Ken
T N. Greeves (senior agricultural officer, North
Region, Nigeria), deputy director of agricultu
Sierra Leone , N M Lucie Smith (assistant dire
of agriculture, Gold Coast), director of agricultu

auritius, A Storrar (agricultural officer, Kenya), ovincial agricultural officer, Kenya, B. C Wills gricultural officer, Northern Rhodesia), assistant rector of agriculture (field services), Kenya, P A llison (senior assistant conservator of forests, igeria), conservator of forests, Western Region, igeria, H B Burgess (senior assistant conservator forests, Nigeria), conservator of forests, Western egion, Nigeria, J W Henderson (assistant conrvator of forests, Gold Coast), senior assistant nservator of forests, Gold Coast, L M Bear eologist, Kenya), geologist, Cyprus, A M Guennel ssistant director), deputy director of the Geological irvey, Tanganyika, A W Peers, agricultural ficer, Kenya, P B. Harris, agricultural officer, orthern Region, Nigeria, H E G Morgan and . F A Murfitt, agricultural officers, Sierra Leone, B Lyons, chemist, Department of Chemistry, ngapore, O Von Knorring, chemist, Geological irvey Department, Federation of Malaya, R ross, fisheries officer, Northern Region, Nigeria, . B Meecham, fisheries officer, Gold Coast, T M ow, assistant conservator of forests, Northern hodesia, R H Graham, assistant conservator of rests, Western Region, Nigeria, R G Lowe, sistant conservator of forests, Northern Region, igeria, W D. Clayton, specialist officer (ecologist), ederation of Nigeria, J. W. Millbank, scientific ficer, East African Agriculture and Forestry esearch Organization, East Africa High Commison, P F Prevett, scientific officer, Sierra Leone, Quarterman, scientific officer, East Africa High mmission, F Raw, senior scientific officer ntomologist), West Africa Cocoa Research Initute, Gold Coast, P B. H Tinker, scientific ficer (chemist), West Africa Institute for Oil Palm esearch, Federation of Nigeria, T Williams, plant thologist (scientific), North Borneo

nnouncements

We regret to announce the death of Sir Arthur Keith, R S, master of the Buckston Browne Research arm, formerly Hunterian professor in the Royal ollege of Surgeons, on January 7, aged eighty-eight

The Paris Academy of Sciences has made the llowing awards, among others Lavoisier Medal to rof F Joliot and Mme Joliot, on the occasion of e twentieth anniversary of the discovery of artificial dioactivity, Henri Poincaré Medal to Prof G aliron, for distinguished work in mathematics, rix Le Conte (350,000 francs) to M Lucien Bull, of e Marey Institute, for his work in devising equipent for ultra-rapid cinematography, clinical electrordiography, application of the electric spark to the nematography of shock waves, etc., Prix Osiris ,000,000 francs) to Emile Borel, for distinguished ork in mathematics

Dr Irvine C Gardner, chief of the Optics and etrology Division of the U S National Bureau of tandards, has been awarded the Frederick Ives edal for 1954 of the Optical Society of America, for istinguished work in optics and his leadership of hers, which have "done much to stimulate progress geometrical optics in this country". This Medal, warded biennially until 1951 and annually since en, was endowed in 1928 in honour of Frederick es, who was distinguished for his pioneer conibutions to colour photography, photo-engraving, ree-colour process printing, and other branches of pplied optics.

The Council of the Institution of Electrical Engineers has elected Mr J R Beard to honorary membership of the Institution for his distinguished services to the profession, more especially in the field of the transmission and distribution of electricity and for his valuable services to the Institution The thirty-third award of the Faraday Medal of the Institution has been made to Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell, for the conspicuous services he has rendered to the advancement of electrical science, and for his distinguished work in the field of nuclear physics and the development of power from nuclear sources

The Road Research Laboratory (Department of Scientific and Industrial Research) is to hold open days this year at both the Materials and Construction Division at Harmondsworth, Middlesex, and the Traffic and Safety Division at Langley, Bucks, on May 12 and 13 The Scottish Branch of the Laboratory at Thorntonhall, near Glasgow, will be open to visitors on June 2 and 3

The fourth annual conference of the Aslib Aeronautical Group will be held at Cranfield during April 1–3 The main discussion will centre on classification, and co-operating in the conference will be the Classification Research Group Full particulars may be obtained from C W Cleverdon, Librarian, College of Aeronautics, Cranfield, Bletchley, Bucks

A symposium on molecular structure and spectroscopy will be held in the Department of Physics and Astronomy, Ohio State University, during June 13–17 There will be discussions of the interpretation of molecular spectroscopic data as well as of methods for obtaining such data In addition, there will be sessions devoted to those phases of spectroscopy of current interest Further information can be obtained from Prof H H Nielsen, Department of Physics and Astronomy, Ohio State University, Columbus 10, Ohio

W G Pye and Co, Ltd, Granta Works, Cambridge, have issued a new illustrated catalogue, Catalogue *J*, which supersedes all previous issues and includes only those instruments which are in current production The instruments described are grouped into eight sections electronic and associated instruments, including geophones, pH meters and Pirani and ionization gauges, galvanometers, electrometers and accessories, general physics, mostly for student use and including many pieces of apparatus designed by the late Dr G F C Searle, magnetic instruments, measuring microscopes, cathetometers and accessories, miscellaneous items, including switches and clocks, potentiometers, and resistance bridges and boxes

The Medical Research Council invites applications for a further series of fellowships in clinical research of the value of £850 a year, tenable at centres in the United Kingdom during the academic year 1955–56 These fellowships are ordinarily restricted to medically qualified British subjects resident in the United Kingdom Applications must be sponsored in each case by the head of the appropriate department in the candidate's university or medical school Forms of application for these fellowships may be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S W 1, to whom they must be returned not later than March 1.

INDUSTRIAL MANAGEMENT IN EUROPE

UNDER the auspices of the British Institute of Management, an outstandingly successful conference was held at Torquay during October 20–23. This was attended by 1,070 delegates, 350 of whom came from European countries as far afield as Yugoslavia and Turkey in the east, Finland in the north and Malta in the south In addition, there were fifty delegates from Commonwealth countries, North and South America, the Philippines and Iceland The largest single delegation outside the United Kingdom came from Germany, with the Netherlands and Scandinavia second and third

The papers covered all aspects of management, and one of the most interesting was presented by M Pierre Bezier, directeur des méthodes mécaniques, Régie Nationale des Usines Renault, Billancourt, who spoke about the implications for management of automation, this is particularly important for industrialists who have to instal and develop the means necessary to launch mass-produced products The acquisition of all the machines necessary for a new manufacturing programme, according to M Bezier, is only possible if a machine-tool industry is in existence which is capable of satisfying a heavy demand within a reasonable delivery time, and such an industry can only exist if a sufficiently large group of customers is available to ensure a steady flow of orders and regular and sufficient work These conditions obtain in the United States, where the domestic market is able to take all the output of the automobile industry and a large part of the domestic equipment industry such as washing machines, refrigerators and plumbing and heating equipment European factories generally have to fall back on American manufacturers or on local industry for their machine tools Most British motor-car factories are in this position

Experience in the use of special machines has made it possible to lay down certain simple rules which can reduce the consequences of unforeseen breakdowns, great importance is attached to the standardization of equipment Equipment should be sufficiently strongly designed to withstand several years of intensive operation, it should also be 'flexible' It is particularly useful to avoid units with a short stroke, as this can cause difficulty when tools are changed, 12 in travel should be considered as a minimum

Many machine builders have remained faithful to hydraulic controls, M Bezier prefers electromechanical systems, the principal advantage of which is that they can be applied equally to drilling, tapping or milling cycles When a piece of equipment goes out of service as a particular model is withdrawn, it is possible to turn it to some other kind of work When a machine begins to show signs of wear and it becomes difficult to continue with precision work, drastic overhauls must be carried out The standardization of machine elements enables this to be completed in a few days

For a long time it was considered that the personnel operating expensive and complicated machines ought to be provided with extensive technical training, and that it would be necessary to envisage a high proportion of supervision and maintenance personnel These two fears have been shown to be without foundation

Discussing the application of psychology to industrial training, Mr A. T. Welford, director of the Nuffield Research Unit, Cambridge, stated th whereas studies of learning form a very large part experimental psychology in the laboratory, little u has been made of them in problems of industr training This is a field ready for developmer First, there is much recent experimental eviden that performance after training is better if t training has been on a task a little more difficult th that for which the man is being prepared Secon there appears to be a growing tendency for t ability to state in words what has to be done to taken as a criterion of proficiency at a task Ma skills are not easily put into words, and it seer possible that trying to do so may, in fact, distort t emphasis upon particular features and so tend disrupt rather than assist the free exercise of t skill

The third point about training is that the way which a task is performed the first time it is met c sometimes have a profound influence upon how it performed afterwards In other words, it is mc difficult to modify a method of work already lear than to learn it in the first instance—a principle w known in games This means that attention to t initial stages of training is very important, it better that a complex operation should be brok down into a number of very small units, each which can easily be mastered on its own, althou together they would be very difficult Rapidity training is not always the best criterion of its succe and more time spent during training may be reward by better performance later, which in turn may le to greater satisfaction in work and lower turnov of labour

Another outstanding paper was that read by Pr G Lehmann, director of the Max-Planck-Institut f Arbeitsphysiologie He discussed the physiologic principles in the rational organization of work an *inter alia*, showed that, in building, it has proved be more economical to use large-sized bricks of weight of 20–30 kgm made of a material with low specific gravity rather than the smaller ones nc used With them it is possible to erect a bri surface six times as large as one built with norm sized bricks at the same cost of energy The reas for this remarkable state of affairs is that often mo than 90 per cent of the total energy spent is us not for the transport of work pieces and tools b for the movements of the human body The emplo ment of big and inert limbs for the transport of small brick is uneconomical Fewer movements wi heavier loads are therefore more advantageous

Prof Lehmann showed that the effect of re pauses is much greater if they are spread even over the working day The best results are achiev if the pauses are taken in relation to the physiologic performance curve over the day, that is, if the are fewer rest pauses in the morning when the m are at their best, and more after the beginning work, or around midday and evening Generall many short pauses are more effective than a few lo ones of the same total duration This follows fro the fact that recovery follows an exponential curv setting in rapidly and continuing more and mo slowly

Short obligatory rest pauses should be establish in industries If on observing physically light wo one finds that 15 per cent of the time is spent eal pauses, and a further 15 per cent is spent for ancillary work, part of which, too, stands for hidden est pauses, it might seem useless to introduce further obligatory rest pauses; results show the contrary. If for every hour an obligatory pause of five minutes s introduced, the number of arbitrary pauses diminishes, together with the time spent on ancillary work. The gain in effective working-time—and therefore production—exceeds by far the loss caused by the introduction of the short obligatory pauses.

For the management of a plant it is important to know whether the limiting factor of production is to be found in the worker or with the technical equipment. Sometimes output does not rise, or even diminishes, after some machine has been replaced by a more efficient one. The reason may be that the worker has lost some of the rest pauses which had been essential for his performance.

The closing address was given by Dr. D. U. Stikker, Netherlands Ambassador to Great Britain, who suggested that in examining responsibility for social questions the task of management is really enormous. Wherever the principle of social responsibility is accepted, profits are increased; but where these principles are not accepted, unrest prevails and all the devices of efficiency are of no avail. In Holland, during the Second World War, when the country was being stripped of its wealth, there was a small group of people—some trade union leaders, ome managers and a few politicians—who saw quite learly that the only way to tackle the problem of econstruction after the War was by the closest o-operation between labour, management and the Government. At that time management accepted its ocial task and so did labour, and together they reated a new institution known as the Foundation f Labour, a body which has done much to build up the prosperity of Holland. This experiment is nprecedented—an experiment in which organized abour and management came together on a permanent basis in one institution to produce a national wage policy in an endeavour to keep price-levels down and to study plans for social security which were submitted to the Government. The years of social peace that followed the setting up of this new nstitution can be illustrated by the decreasing gures of working days lost through labour disputes. n 1953, with a population of 10,000,000 people, not more than 30,000 working days were lost; in 1954 here were practically no further strikes and it was deemed unnecessary to publish figures concerning abour disputes. As this institution came into being n the initiative of management, it would seem that management, at the present time, can play a completely different part from the old days, when it was elieved that profit-making in itself was a sufficient ontribution to the national welfare.

Looking at the different systems in existence in he world to-day, Dr. Stikker said that it is possible o distinguish between three of these. The first ystem is a crude one of unrelenting warfare between wo parties. That system is defended at the present moment in the United States, where a group of ociologists and trade union leaders maintain that he bitter struggle between the parties in itself produces a high standard of living and high efficiency. They claim that the European system of social esponsibility creates conditions of stagnation, low wages and low productivity. They believe that a erce struggle will create efficiency, effective man-our saving devices and highly paid labour. If this system has any value at all, such a system can only exist in a country with an expanding economy, with a highly mobile labour force and with great natural resources. The second system is the system behind the Iron Curtain, a system of complete State control over labour and management, where no disputes are possible because the answer to every dispute is a slave camp. Such a system cannot be accepted by anyone who believes in human dignity and freedom. The third system is the one which occurs mostly in Europe, a system of negotiation; where this does not produce the right result there is the alternative of a panel solution by arbitration. If this is the right system at the present moment, there is no reason for complacency. While this system may be acceptable to management and to the trade union leaders, it may not be acceptable by the rank and file.

Management in Europe should not be content, said Dr. Stikker, with the negative task of preventing strikes. It should look for the positive task of increasing productivity. Here every individual manager has a part to play because industrial unrest is not always due to frustrated wage claims, although that may well be the reason for its origin. Management should not be on the alert only for discontent; it should strive to create an atmosphere where a man derives satisfaction from, and at the same time gets a little praise for, doing a good job. This idea of social responsibility is not new; but to put it into effect is another story. Management could not give a greater contribution to prosperity than by a universal acceptance and application of this principle of social responsibility.

T. H. HAWKINS

DETERMINATION OF VITAMIN A IN NATURAL PRODUCTS AND IN MARGARINE

AT a joint meeting of the Oils and Fats Group of the Society of Chemical Industry, and of the Society of Public Analysts, held at Burlington House, London, on December 1, papers were read on the determination of vitamin A in natural products and in margarine.

Prof. R. A. Morton, in a communication with F. Bro-Rasmussen, recalled that for some years the unit of vitamin A activity was defined as that exhibited by 0·6 μgm. of the precursor, β-carotene. Vitamin A itself was later crystallized and its activity was found to be 3·3 × 10^6 units per gm. The International Unit was re-defined as the activity of 0·3 μgm. of pure crystalline all-*trans* vitamin A or the equivalent weight of vitamin A acetate. Vitamin A is usually determined by the intensity of absorption at the maximum (near 325 mμ) in its ultra-violet absorption spectrum, and a conversion factor of 1,900 (see Table 1) has official sanction internationally as well as in pharmacopœias.

It was inevitable that the reference substance should be all-*trans* vitamin A (acetate), and indeed much of the demand for vitamin A, for example, for the fortification of margarine, is now being met by the synthetic all-*trans* acetate.

When vitamin A is determined by its ultra-violet absorption, the spectrophotometric measurements must be made on solutions in which vitamin A is responsible for a large proportion of the intensity of absorption in the region 300–350 mμ. This condition

Table 1 VITAMIN A ALCOHOLS

	All-*trans* Vitamin A_1	Neovitamin A_1	Vitamin A_2
Potency (I U /gm) × 10^6	3 33*	2 66[3]	1 33[4]
λ_{max} mμ in *cyclo*-hexane	326	328	351
E(1%, 1 cm) at λ_{max}	1,745[2]	1,650[5]	1,350[6,7]
E(1%, 1 cm) at 326 mμ	1,745	1,615	1,050
Conversion factor (that is, potency – E(1%, 1 cm) at 326 mμ)	1,908	1,647	1,267

* By definition

often requires that the vitamin should first be concentrated, for example, into an unsaponifiable fraction or into a chromatographic fraction , but manipulative losses may detract from the advantage gained by improved spectroscopic 'quality'.

The correction procedure of Morton and Stubbs[1] incorporated in official methods now in force is used for discounting 'irrelevant' absorption The procedure makes it essential that the spectrophotometric properties of the material to be estimated shall be known with considerable accuracy , this condition is fully met in the case of all-*trans* vitamin A (see Cama, Collins and Morton[2]) and the correction procedure is indeed very successful for products containing synthetic vitamin A

Natural products, however, such as fish liver oils, contain at least three (and possibly more than three) vitamin A-active substances, namely, all-*trans* vitamin A_1, neovitamin A_1 and vitamin A_2 The latter is generally a minor component (except in some fresh-water fish liver oils), but the variability of the ratio A_1/A_2 may be as troublesome to the analyst as that of the ratio of all-*trans* to neovitamin A

Neovitamin A (the most important of several possible *cis*-isomers) and vitamin A_2 are ignored in the pharmacopœias, the revisers of which are rightly reluctant to take action which might turn out to be premature The properties of vitamin A alcohols are illustrated in Table 1.

In order to display the problem, let it be assumed that in a concentrate (for example, from cod liver oil), for every molecule of A_2 there are eight of A_1, six as all-*trans* and two as neovitamin A_1 Using *cyclo*hexane as solvent, the intensity of absorption would be

E(1%, 1 cm) at 326 mμ
All-*trans* contribution, 6/9 of 1,745 = 1,163 3
Neovitamin A_1 contribution, 2/9 of 1,615 = 358 9
Vitamin A_2 contribution, 1/9 of 1,050 = 116 7
1,638 9

The potency would be

All-*trans* contribution, 6/9 of 3 33 = 2 22 × 10^6 u /gm
Neovitamin A_1 contribution, 2/9 of 2 66 = 0 593 ,,
Vitamin A_2 contribution, 1/9 of 1 33 = 0 148 ,,
2 961

and the overall conversion factor would be

$$2\ 961 \times 10^6/1{,}638\ 9 = 1{,}807$$

The overall factor will fall as the proportion of neo-vitamin A_1 or vitamin A_2 increases, and will reach 1,687 with 30 per cent A_2, 30 per cent neo- and 40 per cent all-*trans* vitamin A_1

If correction is made for irrelevant absorption, using three points on the curve for all-*trans* vitamin A_1, the neovitamin A contribution is reduced by 20 per cent (*cyclo*hexane) and that of vitamin A_2 b 90 per cent (that is, it is almost eliminated) For mixture in which the proportions all-*trans*/neo-/A are 70/21/9, it is known that by reason of a compensation in which over-correction of neovitamin A absorption matches the lower potency (2 66 instea of 3 33 × 10^6 u /gm), the British Pharmacopœi and United States Pharmacopœia methods lead t much more trustworthy estimates of vitamin A potency than might have been expected

Three cod liver oils and two rich fish liver oil were tested at Liverpool using the British Pharmacopœia method and at Copenhagen using th chromatographic method described below Th degree of agreement was on the whole good. Th Liverpool estimates of vitamin A_2 content wer based on the colour test (antimony trichloride intensity at 693 mμ, and were higher than thos based on chromatographic separation of the vitami

The estimates of neovitamin A content using th Robeson and Baxter[8] method, which rests o different rates of adduct formation with malei anhydride, showed only moderately good agreemen with the results of chromatography

A paper on the chromatographic separation o vitamin A-active compounds in cod liver oil by F Bro-Rasmussen, W Hjarde and Olga Porotnikof from the State Vitamin Laboratory, Copenhagen was read by Mr G A J Pitt, of the University o Liverpool.

The adsorbent is dicalcium phosphate activated a described by L A Moore[9] Using the unsaponifiabl fraction from 3 gm of a cod liver oil (about 3,000 I U and a chromatographic column 50 cm long an 3 cm in diameter, the vitamin A was carried dow the column by means of light petroleum. Development of the chromatogram was completed by th use of 600 ml. of light petroleum-ether (16 1 v/v collected in 15-ml portions from the first appearanc in the eluate of material giving a blue colour wit antimony trichloride The material collected in th first 225 ml was almost entirely neovitamin A, an the all-*trans* vitamin A_1 was completely eluted in th next 225 ml , with vitamin A_2 following in the nex 150 ml The separation was clean and the spectra c 15-ml portions at the 'peak' elution of each vitami A-active component were precisely characteristic an agreed with published information

The recommended procedure is to take enough co liver oil to yield about 1,600 I U vitamin A activit and to chromatograph the unsaponifiable fraction o a 10-cm column of activated dicalcium phosphat A good deal of material responsible for irrelevan absorption can be eluted before any vitamin A this is discarded and the total vitamin A-activ material is then eluted with light petroleum-ethe The solvent is removed and the residue dissolve in absolute ethanol, and the ultra-violet absorption i measured at 310, 325 and 350 mμ. The value c E(1 %, 1 cm) at 325 mμ is taken as a measure of tot vitamin A concentration. The unsaponifiable matte is then chromatographed on a long column (60 cm > 1 5 cm). The eluents (light petroleum–ether, 400 ml 16 1 v/v, and 400 ml , 12 1 v/v) are collected i 10-ml portions and the values of E at 325 mμ ar measured Three maxima are shown when E i plotted for successive 10-ml portions, and it is eas from the graph to combine the portions containin neovitamin A_1, all-*trans* vitamin A_1 and finall vitamin A_2 The chromatography results in recover of about 90 per cent of the absorption at 325 m btained after the simple elimination of irrelevant bsorption using the short column. It is assumed hat the loss of 10 per cent is not selective and the bserved values of E at 325 mμ for the three vitamin -active components are accordingly scaled up The ll-*trans* vitamin A_1 absorption (in $E(1\ \%,\ 1\ \text{cm})$ '25 mμ) multiplied by 1,800 gives its contribution in nternational units, similarly, the neovitamin A_1 bsorption at 325 mμ is multiplied by 1,610 and that f vitamin A_2 by 1,060 (solvent is ethanol)

The British Pharmacopœia method is simple and ortunately gives trustworthy results for the total itamin A_1 activity The vitamin A_2 contribution ay be determined separately

J Walter Lord and Miss P M Bradley submitted method for the spectrophotometric estimation of itamin A in margarine The amount of vitamin A c 30 I.U./gm) is not great and the unsaponifiable raction shows a good deal of irrelevant absorption erived from the constituents of the fat or from dded carotenoids or dyes Boldingh and Drost[10] escribed an effective procedure for obtaining from argarine a fraction practically free from irrelevant ltra-violet absorption, and the method has received fficial recognition[11] It depends on chromatography sing two specially activated adsorbents in tandem olumns, and although simplifications of the method ave been suggested (for example, by Rosner and an[12]) it is still necessary for the analyst to undertake two preparations of specially activated alumina

The modified method of Lord and Bradley is more onvenient It is based on a simple chromatography sing bone meal, an adsorbent advocated by Mann[13] nd used by Goodwin and Morton[14] for separating arotene and vitamin A unsaponifiable extracts from argarine Commercial defatted bone meal is suitble if it passes an 80-line sieve but is retained by a 70-line sieve These limits are not critical, but articles of this size allow a reasonable rate of flow f solution and also permit absorbing impurities to e separated from vitamin A

The unsaponifiable fraction from 10 gm of mararine is dissolved in petrol (boiling point, 80–100°) nd transferred to a column of bone meal (9 in × in) already full of petrol The yellow dye or the dded carotene can be washed through the column y means of petrol (slight air-pressure is useful) hen the eluate is no longer coloured, the solvent is hanged to petrol containing ether (16 per cent v/v) nd the eluate is then collected in 5-ml portions he tubes containing vitamin A are identified by sing the Carr–Price test on very small portions of luate Aliquots are withdrawn and united for pectrophotometric measurements at 315, 325 and 35 mμ

Vitamin A alcohol could be recovered from the olumn without loss or spectroscopic impairment hen it was added to the unsaponifiable fraction rom unvitaminized margarine, the average 'recovery' as 108 per cent, in close agreement with experience f the official method (compare Morgareidge[15]) The igh 'recovery' is due to the presence of material xhibiting irrelevant absorption The reading at 15 mμ is always somewhat greater than that of 35 mμ, but the irrelevant absorption at 335 mμ is ery small The difference between readings at 315 mμ nd 335 mμ gives a good approximation to the irrelevant absorption at 325 mμ When this correction is pplied, 'recovery' is nearer 100 per cent Comparison f the results of the new method and the official ethod showed excellent agreement, and many workers may find the simplicity of the bone meal method attractive

A brisk discussion followed The possibility that the neovitamin A_1/all-*trans* ratio might be altered by saponification was mentioned The constancy of bone meal was also queried, however, this adsorbent is reproducible and can be used several times.

[1] Morton, R A, and Stubbs, A L, *The Analyst*, 71, 348 (1946)
[2] Cama, H R, Collins, F D, and Morton, R A, *Biochem J*, 50, 48 (1952)
[3] Harris, P L, Ames, S R, and Brinkman, J H, *J Amer Chem Soc*, 73, 1252 (1951)
[4] Shantz, E M, and Brinkman, J H, *J Biol Chem*, 183, 467 (1950)
[5] Chatain, H, and Debodard, M, *C R Acad Sci, Paris*, 232, 355 (1951)
[6] Shantz, E M, *Science*, 108, 417 (1948)
[7] Cama, H R, and Morton, R A, *The Analyst*, 78, 74 (1953)
[8] Robeson, C D, and Baxter, J G, *J Amer Chem Soc*, 69, 136 (1947)
[9] Moore, L A, *Indust Eng Chem, Anal Ed*, 14, 707 (1942)
[10] Boldingh, J, and Drost, J R, *Amer Chem Soc*, 28, 480 (1951)
[11] Statutory Instruments, No 613 (1954)
[12] Rosner, L, and Kan, H, *J Assoc Off Agr Chem*, 37, 887 (1954)
[13] Mann, T B, *The Analyst*, 68, 233 (1943)
[14] Goodwin, T W, and Morton, R A, *The Analyst*, 71, 15 (1946)
[15] Morgareidge, K, *J Assoc Off Agr Chem*, 37, 748 (1954)

NATIONAL RESEARCH COUNCIL OF CANADA

ANNUAL REPORT FOR 1953–54

THE thirty-seventh annual report of the National Research Council of Canada* covers the year ended March 1954, and, following the pattern of the last report, includes, besides the president's report and the financial statement, the annual report of Canadian Patents and Development, Ltd, for the year ended March 31, 1954 Pilot-plant operations on the Cambron process for the direct oxidation of ethylene were discontinued, but the pilot plant is being maintained in a standby condition, and the Applied Chemistry Division of the National Research Council has carried out further research on reactors for the Company The Company has also established a Development and Promotion Section to encourage contact with industry and the use of inventions controlled by the Company

The president's report records that during 1953 the National Research Council provided two million dollars in 420 awards and 230 scholarships and fellowships for fundamental research in the universities Its scientific staff numbered 535, with 679 non-professional technical personnel and 741 others employed in services, maintenance and administration as well as some eighty post-doctorate Fellows Technical inquiries from Canadian industries are now running at the rate of eight thousand a year, and already some eighteen hundred science graduates have gained advanced training in research by the Council's extra-mural support of fundamental research New buildings for the Divisions of Applied Chemistry, Building Research and Radio and Electrical Engineering were completed during the year, and additions made to the thermodynamics building

In the Division of Applied Biology, the industrial possibilities of the improved citric acid fermentation process as an outlet for Canadian sugar-beet molasses are now being tested in the pilot plant. Research on dairy products has indicated the protective action of dissolved lactose on milk proteins during frozen storage, while electron microscope studies, in collaboration with the Department of Agriculture, have established the way in which a virus attacks bacterial disease of crop plants and the size and shape of the virus. The role of lipoxidase, an enzyme occurring in plant tissues, in the oxidation of fats is being evaluated, and radioactive tracer techniques have shown that in detached sugar-beet leaves a ten-second photosynthetic period yields significant amounts of such complex molecules as cellulose, as well as simple sugars and amino-acids

---

* Thirty-seventh Annual Report of the National Research Council of Canada, 1953–54, including the Annual Report of Canadian Patents and Development, Limited (N R C No 3286) Pp 50 (Ottawa National Research Council, 1954)

In the Prairie Regional Laboratory, Saskatoon, the major effort is being concentrated on production from agricultural wastes and surpluses of such substances as enzymes, antibiotics, vitamins for feed supplementation, and other compounds obtainable only by biological synthesis. Current investigations include studies on the physiology and biochemistry of living plants, the mechanism of fermentation processes using sugar or carbohydrate nutrients, and the chemistry of such plant materials as starches, sugars, cellulose, lignin, proteins, fats and oils The process for separating prime starch and vital gluten from wheat flour has been improved, and trials of the new fluidized-bed dryer indicate that wheat can be dried at air temperatures greatly in excess of 180° F. (82 2° C.) without damage or loss in baking quality. The Maritime Regional Laboratory, Halifax, has been concerned largely with fundamental and applied aspects of the utilization of seaweed. Rockweed appears to be a less suitable source of alginate than kelp The distribution of amino-acids in the proteins of several species of seaweed has been determined, the chemical structure of fucoidin from rockweed clarified by isolation of a new crystalline disaccharide, maritol, and carrageenin from Irish moss fractionated into a polymer which appears to be responsible for the high viscosity of the sol fraction and another governing gel strength.

In the Division of Pure Chemistry, the red pigment uroporphyrin I has been synthesized and its structure confirmed, while it has also been shown that the two alkaloids, hordenine and gramine, generated in sprouting barley, are formed from amino-acids, the first from tyrosine, and the second from tryptophan Further information about the internal structure of the hydrogen peroxide molecule has been obtained in low-temperature measurements by the Low Temperature Colorimetry Section in collaboration with workers at Laval University, and the thermodynamic functions of hydrogen peroxide gas have been calculated up to 1,200° C A thermal diffusion column built by the Section on Physical Properties of Liquids and Gases for the separation of krypton isotopes gave a krypton-84 containing only 2 4 per cent of krypton-86

In the Division of Applied Chemistry, besides work on the catalytic oxidation of ethylene, much effort has been spent on the evaluation of silver catalysts for the process In collaboration with the Canadian Research Institute of Launderers and Cleaners, a study of the sorption of surface-active agents by textile fibres was completed, and studies were being made of the factors affecting the soiling characteristics of textile fibres, of the microbiological and ultra-violet breakdown of cellulosic fibres, and of methods of measuring damage in the newer synthetic fibres The study of inhibitors for the corrosion of metals in water and in glycol an freeze systems continued, as well as developme work on the production of high-purity single cryst of germanium. A study of the decomposition of t polymerizing and blowing agent 'Porophor *N*' w completed, and work was started on the oxidation polyvinyl alcohol by Fenton's reagent

In the Division of Physics a universal detector f atomic and molecular beams has been develop which has already been used in the study of silv gold and boron. The presence of free aldehy radicals when acetaldehyde, formaldehyde or glyox is irradiated by ultra-violet light has now been esta lished, and the Spectroscopy Laboratory has al resolved the Raman spectra of benzene vapour a obtained precise values for the geometrical dime sions of the benzene molecule Important informati about the nature of the primary cosmic radiati and on nuclear reactions caused by cosmic rays h been obtained from a microscopic study of plat exposed in balloons at altitudes of more th 100,000 ft , while, in a theoretical evaluation of oth experimental data on the upper atmosphere, t variation of the dissociation of molecular oxygen in atoms with height has been derived and the variati of the electron concentration in the *E*-layer calculate Apparatus is being set up to study the electrical a other properties of metals under pressures up 10,000 atmospheres In the Applied Physics Branc studies by the Acoustics Laboratory indicate th ultrasonics are ineffective as repellents for duc and ring-billed gulls An improved ear defender h been developed to the prototype stage Experimen were in progress on the determination of the gravi constant by direct observations on a falling bo using modern optical and electronic development A new technique has been developed which increas the precision and convenience of interferometry measuring length, and the extension of existi ground control points by mathematical computati from measurements on air photographs was al being examined in co-operation with the Universi of Toronto. A set of carbon-filament lamps f photometric standards has been calibrated using small refractory tube immersed in molten platinun and the amount of radiation in the beam emitted cobalt beam therapy units was being measured the Radiology Laboratory A photographic 'came calibrator' has been constructed for air cameras a put into use.

The dedication on October 23, 1953, of the ne Building Research Centre, which is believed to the first building of its kind designed to serve t general needs of building research, was the cu mination of the first three-day Conference on Buildi Research to be held in Canada. The new buildi does not include accommodation for the Division work on fire research, which has progressed steadi during the year, in relation both to fire losses and civil defence. The Division continues to opera Canada's only sound chamber for acoustical researc in relation to buildings, while important results o the reflective insulation of walls in cold weather hav been obtained by the Division in the Prairie Region Laboratory at Saskatoon Work on the revision of th national building code continued, and the Divisio broadened its work in the field of technical housin research.

The Division of Mechanical Engineering continue its investigations of means of protecting aircraft an engines against de-icing, while in aerodynamics th

Science and the Common Understanding

(The Reith Lectures for 1953)

J. ROBERT OPPENHEIMER

' Dr Oppenheimer can speak with authority, for he combines the highest technical competence with administrative experience and wide interests . A touch of the poet gives him the power to express the scientist's situation in our time, above all the underlying yearning for simplicity and clarity baffled by current complexities and difficulties '

Times Literary Supplement 8*s* 6*d* *net*

Some Fundamentals of Petroleum Geology

G. D. HOBSON

Dr Hobson's book is concerned with the nature of oil accumulation, and with ideas on the origin of oil and its aggregation into a commercial oil pool The book will interest not only students, but also those already engaged in the search for, and development of, oil accumulations

Illustrated 18*s* *net*

Meteor Astronomy

A. C. B. LOVELL

It is nearly thirty years since the last comprehensive study of meteors was published This book gives a full account of the visual, photographic, and radio techniques for the study of meteors This is followed by seven chapters on the number, mass, and velocity distribution of sporadic meteors, and by seven chapters on the major meteor showers Finally the cosmological problem of the existence of the meteor debris in the solar system is considered

Illustrated 60*s* *net*

OXFORD UNIVERSITY PRESS

Smith's for Professional Books

Books on scientific, industrial, chemical, electrical, mechanical and other specialized subjects can be quickly supplied through your local Smith's shop or bookstall.

Your copies of NATURE can be bound into attractive volumes, and all your stationery and printed matter supplied through our local branch

W.H.Smith&Son

for SPECIALIZED BOOKS

HEAD OFFICE STRAND HOUSE, LONDON, W C 2

National College of Horology and Instrument Technology

at the NORTHAMPTON POLYTECHNIC
St John Street, London, E C 1

SESSION 1954–1955

Course of Seven Evening Lectures

on

PRECISION TIMEKEEPING

by lecturers from The Royal Observatory, National Physical Laboratory and Post Office Engineering Dept.

FRIDAY EVENINGS: 6.30–8.30 p.m.
commencing 21st JANUARY, 1955

The course has been planned as a review of modern methods of precise timekeeping and standards of time and frequency for horologists, physicists and engineers

•

The fee for the course is £2 2s Students may enrol by post or by personal attendance at the College up to 17th January, 1955 The Northampton Polytechnic, in which the College is accommodated, is a few minutes walk from the Angel Underground Station (N Line)

Technical Books

Ready in February, 1955

GRIGNARD REACTIONS OF NONMETALLIC SUBSTANCES

by M S KHARASCH and OTTO REINMUTH

Throughout the planning and execution of this work the authors have borne in mind the imperative that information must be easily and quickly accessible to the user who employs it primarily as a ready reference compendium

Roy 8vo	1384 pages	About £7

ADVANCED ORGANIC CHEMISTRY

by E E ROYALS

A practically useful integration of descriptive fact and unifying theory for the advanced student, presented in such a manner that he may attain a mature grasp of the subject

Roy 8vo	948 pages.	About 63*s*

ELEMENTS OF STATISTICAL MECHANICS

by D TER HAAR

Demy 8vo	468 pages	45*s*

BREAD

The Chemistry and Nutrition of Flour and Bread with an Introduction to their History and Technology

by LORD HORDER, G C V.O , M D , F R C P , SIR CHARLES DODDS, M V O , M D , D Sc , F R C P , F R S , and T MORAN, C.B E, D Sc , Ph D

Demy 8vo	Illustrated	18*s* net

ACTIVE NETWORKS

by C V RIDEOUT

This book is intended primarily for those who have studied the physics of vacuum tubes and related devices as well as the fundamentals of the theory of passive linear networks

Demy 8vo.	485 pages	42*s* net

CONSTABLE & CO. LIMITED
10-12 ORANGE STREET . LONDON, W.C.2

McGRAW-HILL LONDON

Automatic Feedback Control System Synthesis

JOHN TRUXALL

Associate Professor of Electrical Engineering, Polytechnic Institute of Brooklyn, Associate Professor of Electrical Engineering, Purdue University

This work is a complete up-to-date presentation of the methods useful in the design of feedback systems The highly developed theories of the design and synthesis of linear systems are covered in detail, and it concludes with analysis and design of non-linear systems

A solid theoretical foundation is placed under the elementary design techniques The Laplace transformation is used in connection with design, in contrast to the conventional approach

Synthesis of feedback systems in terms of polezero configurations is considered in detail with an extended discussion of the root-locus method and a full development of the concept of initiating design in terms of the poles and zeros of the closed-loop system function

9 × 6 inches	775 pages	Approx £5

Engineering Cybernetics

H S TSIEN

Goddard Professor of Engineering, California Institute of Technology

FLORENCE GUGGENHEIM

Jet Propulsion Centre, California Institute of Technology

This work aims to establish engineering cybernetics as a new branch of engineering science Its purpose is to study those parts of the broad science of cybernetics which have direct engineering applications in designing controlled or guided systems It includes topics normally treated in books on servomechanisms, but is predominated by theoretical analysis

About two-thirds of the material treats new subjects, many of which have never before appeared in book form

This is a truly significant text and reference book developed for a course on the theory of stability and control It should also serve as an introductory text to control engineering for physical and mathematical scientists who may wish to do research in the field

9 × 6 inches	301 pages	46s 6d

Available shortly from your Bookseller

MACMILLAN BOOKS

Intermediate Chemistry

Sixth Edition

T. M. LOWRY, C.B.E., M.A., D.Sc., F.R.S.

Late Professor of Chemistry in the University of Cambridge

A. C. CAVELL, M.A., B.Sc.

Senior Science Master at Uppingham School

The main intention of this new edition of *Intermediate Chemistry* has been the re-writing of the Organic Section. Several changes have been made to the Inorganic Section, and there have also been a number of other alterations to and extensions of the work, which is designed to provide a complete text-book of chemistry for Intermediate and General Certificate (Advanced and Scholarship) Examinations. 18*s.*

Semimicro Qualitative Analysis

A Course in Applied Chemical Equilibrium

EDWIN O. WIIG, Ph.D., WILLARD R. LINE, Ph.D., and JOHN F. FLAGG, Ph.D.

This revision of *Semimicro Qualitative Analysis*, while retaining the experimental procedures and much of the form of the earlier text, has been almost completely rewritten. The theoretical section has been considerably expanded, and a large number of problems of varying difficulty (with the answers to many of them) have been added. The sections on special procedures for ferro- and high-aluminium alloys have been modified on the basis of student experience. 25*s*

Functions of a Complex Variable

THOMAS M. MACROBERT, M.A., D.Sc.

Professor of Mathematics in the University of Glasgow

This book is designed for students who, having acquired a good working knowledge of the calculus, desire to become acquainted with the theory of functions of a complex variable, and with the principal applications of that theory. In order to avoid making the subject too difficult for beginners, the author has abstained from the use of strictly arithmetical methods. *Fourth Edition* 20*s*

From Small Beginnings

E. N. da C. ANDRADE, D.Sc., Ph.D., LL.D., F.R.S.

This little book is based on a series of six television talks given by Professor Andrade, and is the result of letters which were occasioned by them. In it he deals with some of the experiments and thoughts behind a few simple scientific discoveries which have led to such advanced developments as the radio, the aeroplane, the motor car, and the electric lamp. 3*s.* 6*d.*

All prices are net

St. Martin's Street, London, W.C.2

Some Publications of the

CHILEAN IODINE EDUCATIONAL BUREAU

ELEMENT NO 53
TECHNICS OF IODINE
DISINFECTION OF WATER
IODINE PHARMACEUTICALS
CONTRAST MEDIA FOR RADIOGRAPHY
IODINE ASPECTS OF CATALYTIC CHEMISTRY
IODINE—ITS PRODUCTION AND INDUSTRIAL USES
BIBLIOGRAPHY OF IODINE IN CATALYSIS
IODINE AND PLANT LIFE
INDUSTRIAL HORIZONS
FOOD TECHNOLOGY

Copies are available on request without charge For particulars of other iodine literature, or advice on iodine questions, please write to

Chilean Iodine Educational Bureau
Stone House, Bishopsgate, London, E.C.2

SINGER
Micromanipulators

Singer (High-power) Micromanipulators are suitable for use under magnifications of from × 100 to × 1,000 diameters *plus*, as described by Barer and Saunders-Singer in the *Quarterly Journal of Microscopical Science*, Vol. 89, pp 439-447, December, 1948

Singer Microdissectors (Low-power Micromanipulators) are suitable for use under magnifications of from 1 to ×200 diameters and are described by Barer and Saunders-Singer in the *Journal of Scientific Instruments*, Vol 28, pp 65-68, March 1951

●

SINGER INSTRUMENT COMPANY LTD.
83, London Street, Reading

H. K. LEWIS ESTABLISHED 1844
for all books

ON PURE AND APPLIED SCIENCE
including
CHEMISTRY : BIOLOGY : PHYSICS
MATHEMATICS, ENGINEERING AND AGRICULTURE, etc
Catalogues on application, please state interests

H. K. LEWIS & Co. Ltd., 136 Gower Street
Telephone] **LONDON, W.C I** [EUSton 4282

The SCIENTIFIC BOOK SUPPLY SERVICE
(T FREDERICK DE LOCHE)

LIBRARIES PURCHASED
Consult us whenever you wish to buy or sell
HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

ublished JANUARY, 1955

ANNUAL REVIEW OF PSYCHOLOGY

VOLUME 6 (1955)

ditor
C P Stone

ssociate Editor
Q McNemar

ditorial Committee
J E Anderson
N D Cameron
J G Darley
C T Morgan
C P Stone
R L Thorndike

'ublisher
Annual Reviews, Inc
Stanford, California, U S A

'rice
$7 00 postpaid (U S A)
$7 50 postpaid (Foreign)

lso Available
Volumes 1 (1950) to 5 (1954)

"Graduate students, researchers, and professionals in psychology and related disciplines will welcome these annual reviews for their inestimable aid in affording an overview of 'what's new' in psychology."
—*Personnel Psychology*, Summer, 1954

Contents. Child Psychology, *M Radke-Yarrow and L J. Yarrow*; Learning, *K. MacCorquodale*, Vision, *G. J Thomas*; Hearing, *I J Hirsh*, Somesthesis and the Chemical Senses, *G Weddell*; Individual Differences, *R M W Travers*; Personality, *J. Nuttin*; Social Psychology and Group Processes, *L Festinger*; Industrial Psychology, *S R Wallace, Jr and J Weitz*, Comparative Psychology, *D R Meyer*, Physiological Psychology, *H -L Teuber*, Abnormalities of Behavior, *F J Kallmann and G Baroff*; Theory and Techniques of Assessment, *J M Butler and D W Fiske*; Psychotherapy, *P E. Meehl*; Counseling, *N Hobbs and J Seeman*, Statistical Theory and Research Design, *L V Jones*, Educational Psychology, *D G Ryans*; Problem Solving and Thinking, *D. W Taylor and O W McNemar*

517 pages Cloth Bound . Author and Subject Indexes

'N SALE BY: **ANNUAL REVIEWS, INC.,** STANFORD, CALIFORNIA, U.S.A.

[K Lewis & Company, Limited, 136 Gower Street, London, W C 1, England. Maruzen Company, Limited, 6, Tori-Nichome Nihonbashi, Tokyo, Japan

Scientific Circulations Ltd.

We have extensive stocks of Technical Journals, Periodicals and Textbooks Special terms for Technical and Commercial Libraries All Scientific and Technical publications purchased

111, Eastbourne Mews, London, W.2

Telephone AMBassador 6934

THE MUSEUM BOOK STORE, LTD.

25 Devonshire St., London, W I
(Welbeck 1340)

Buy and sell Scientific Journals and Periodicals and Learned Society Publications, in all languages Librarians, and others, should send us their list of "wants", or duplicates for sale *Binding undertaken*

WHELDON & WESLEY, LTD.

Specialists for 100 years in

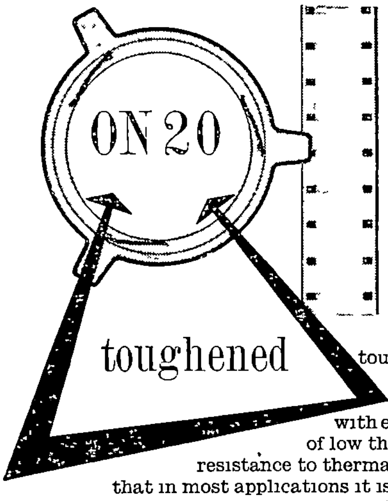
BIOLOGICAL & GEOLOGICAL BOOKS

Catalogues on Request

●

83/84 BERWICK STREET • LONDON • W.1

Books Bought



A process of toughening has invested Chance ON 20 heat-absorbing glass with even greater qualities of low thermal expansion and resistance to thermal shock This means that in most applications it is no longer necessary to take elaborate precautions in mounting or to use filters made up of strips Heat absorption and light transmission remain unchanged ON 20 is the glass for almost all applications where a cool light of high intensity is required and the filter can be used in flat form Toughened ON 20 is available to the Trade to special order but is not at present stocked in a range of standard sizes If your order does not specify 'toughened' we shall assume that ordinary ON 20 is required

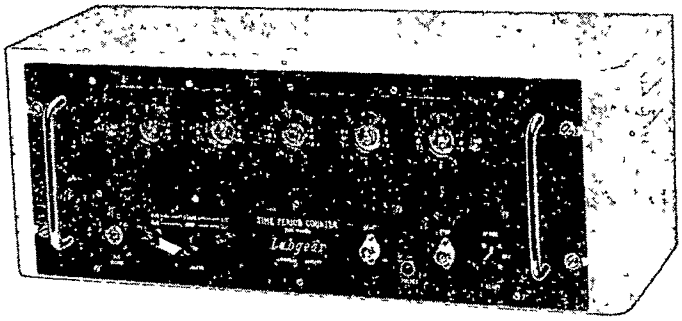
Chance GLASS *For Science, Industry and the Home*

CHANCE BROTHERS LIMITED
HEAD OFFICE GLASS WORKS SMETHWICK 40 BIRMINGHAM LONDON OFFICE 28 ST JAMES'S SQUARE S W 1 BRANCH WORKS GLASGOW, ST HELENS AND MALVERN

Precision Timing!

TIME-PERIOD COUNTER

D.4108



An inexpensive crystal controlled Counter-Chronograph which operates in the range 10 to 10^{-4} seconds for the accurate measurement of the time interval between two events.

An extremely flexible triggering arrangement permits the counter to be operated from

(a) Two consecutive pulses, having a common origin
(b) Two pulses derived from independent sources
(c) A mechanical contact sequence involving s/c Start—o/c Stop, i.e. closed during period under observation, or alternatively,
(d) o/c Start—s/c Stop, i.e. open during the period under observation.

Quartz crystal frequency 10 Kc/s—accuracy 0.02% over a temperature range of —10°C to +70°C.

The normal time-count capacity of 10 seconds may be extended to ten thousand seconds by the addition of Dekatron Register D.4019/V, or to one million seconds by the addition of Dekatron Counter D.4104/B.

Supplied complete with dust cover for standard G.P.O. rack mounting.

Price in U.K. £100

Bench mounting cabinet available at extra cost

Labgear (Cambridge) Ltd.

WILLOW PLACE
CAMBRIDGE

Telephone
Cambridge 2494/5

Telegrams
"Labgear Cambridge"

Rapid centrifugal preparation

with the Spinco Model L

ULTRACENTRIFUGE

- VACUUM
- 162 ml – 40,000 rpm
- REFRIGERATED

FULLY-AUTOMATIC features make the Spinco Model L Preparative Ultracentrifuge operationally self-supervising Simple speed- and time-controls are preset by operator and electronic unit brings rotor to speed, times run, and decelerates with smoothly operating automatic brake

Various sizes and types of interchangeable rotors mount in operating chamber with instantaneous coupling Time between runs, using pre-loaded rotors, is less than a minute Speed and vacuum are established almost simultaneously Acceleration time for the 40,000-rpm rotor is only four minutes

SAFETY FEATURES include automatic overspeed cutout, interlocks to prevent running at high speeds without vacuum in chamber and prevent breaking vacuum or opening chamber while running at high speeds Rotor chamber is encased in thick double steel guard

Unit is self-contained, of worktable height, and requires only electric connection for installation Spinco electric drive and gearing system are of types proved in more than 100,000 hours of actual field operation Self-balancing feature eliminates weighing of loaded tubes Controllable refrigeration holds rotors and contents at any temperature down to -5 C

In operation, the Model L applies forces up to 144,000 times gravity on 162 ml of material at a maximum speed of 40,000 rpm Individual rotor tubes have sealing caps—are available in plastic or metal Rotors provide second vacuum seal in quickly-detachable cover with integral lifting device Wide selection of rotors is available with largest holding 1700 ml—limited to 20,000 rpm

Send for details

Spinco

SPECIALIZED INSTRUMENTS CORPORATION

BELMONT 6, CALIFORNIA

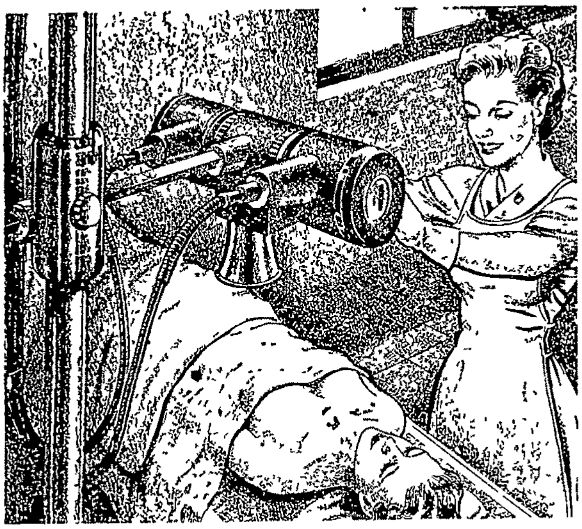
REPRESENTATIVES

Great Britain
HAWKSLEY & SONS, LTD
17 NEW CAVENDISH ST
LONDON W 1

Western Europe
ANALIS
14 RUE DEWEZ
NAMUR, BELGIUM

Scandinavian Countries
LKB Produkter
Fabriksaktiebolag
Postaddress Box 12035
Stockholm 12, Sweden

Australia
H B SELBY & CO
254A GEORGE ST
SYDNEY, N S W , AUSTRALIA



Correct Diagnosis depends on

CONSTANT VOLTAGE

Medical science to-day relies to an increasing degree on electronic instruments for the diagnosis of disease The accuracy of the results obtained is of vital importance and is dependent on the reliability of the electricity supply available ADVANCE Constant Voltage Transformers provide the means for regulating the inevitable fluctuating mains voltages which both shorten the life and impair the efficiency of such equipment They are used in many hospitals and medical laboratories for this very purpose A wide range of models is available with ratings from 4 watts to 6 kilowatts All these models provide a stabilized output voltage to within ±1 per cent for mains variations of up to ±15 per cent

Full details of Advance Constant Voltage Devices are given in folder N/28 gladly sent on request.

CVT

Constant Voltage Transformers

Advance

THE CVT SPECIALISTS

ADVANCE COMPONENTS LTD, MARLOWE RD, WALTHAMSTOW, LONDON, E 17. Phone LARkswood 4366

GD

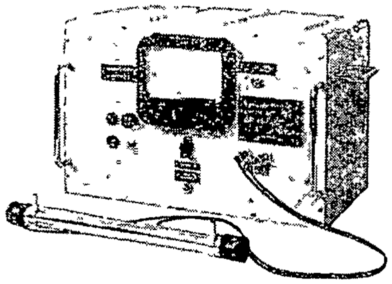
GRUBB PARSONS

A NEW INSTRUMENT

THE

SONIC GAS ANALYSER

Enquiries Welcomed



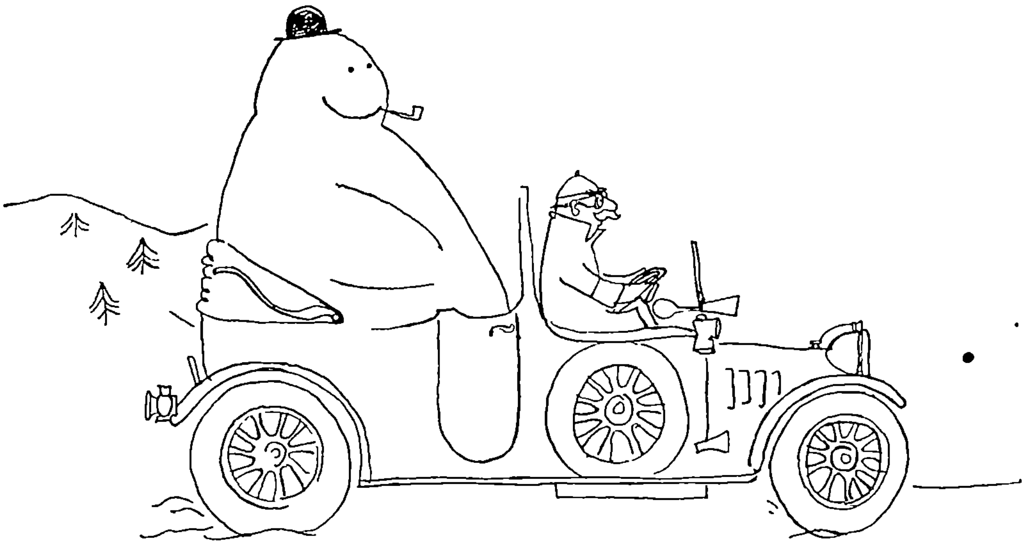
Enquiries Welcomed

This instrument depends on the variation with composition of the velocity of sound in gases Continuous analysis of many gas mixtures is possible Maximum sensitivity full scale for 1% by volume of one component A typical application is the determination of the concentration of trichloroethylene vapour in air

SIR HOWARD GRUBB, PARSONS & COMPANY

WALKER GATE, NEWCASTLE UPON TYNE, 6

PROPRIETORS C A PARSONS & COMPANY LIMITED



Purer than the driven snow !

ASK T. B. FORD for the answer to any filtration problem, and a perfectly pure and lucid filtrate is yours. Ford's are experts in filtration. They make filtration media for every type of filter—and the standard of efficiency is unsurpassed.

From Ford's, you can obtain filtration media so efficient that they can be used to remove contaminating bacteria and moulds, thus sterilizing the liquids passed through them. This thorough filtration is achieved by the careful, precise admixture of asbestos fibres and cellulose, providing a mat that retains a high degree of porosity and permits a high rate of flow. Ford's Sterimats and Claraid not only filter but adsorb any micro-organisms that would spoil an otherwise stable, immaculate, crystal-clear filtrate.

Twenty years of continuous laboratory research and experiment have made T. B. Ford Ltd *the* authority on every aspect of filtration media. And they make the best in the world.

This laboratory service is filtration NEWS!

Ford's provide a laboratory service, staffed by a team of experts, which is available to all manufacturers, free of charge. Some manufacturers, with their own fully-equipped laboratories, simply want Ford's to check and confirm their own research findings. Others call upon Ford's to solve some particular problem in their filtration process, whether directly concerned with the media itself or not. Whatever the problem, Ford's will gladly undertake the necessary laboratory research. Write to T. B. Ford Ltd., Laboratory Service, 101 High Holborn, London, W.C.1.

Famous chemical products are filtered by FORD'S

T. B. FORD Ltd

FORD 428 MILL

REGISTERED TRADE MARK

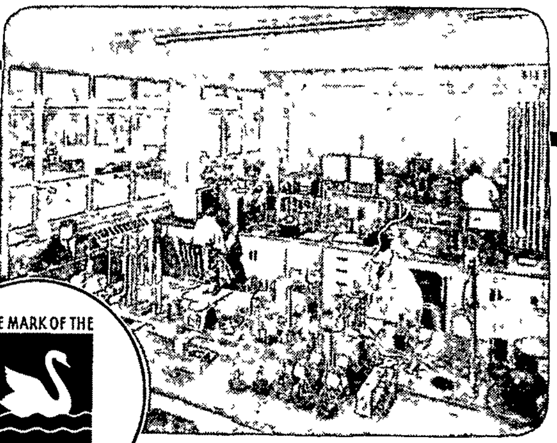
T. B. FORD LTD., TECHNICAL ADVISERS ON FILTRATION MEDIA AND MANUFACTURERS OF STERIMATS, CLARAID, FILTER PULP AND FILTER PAPER

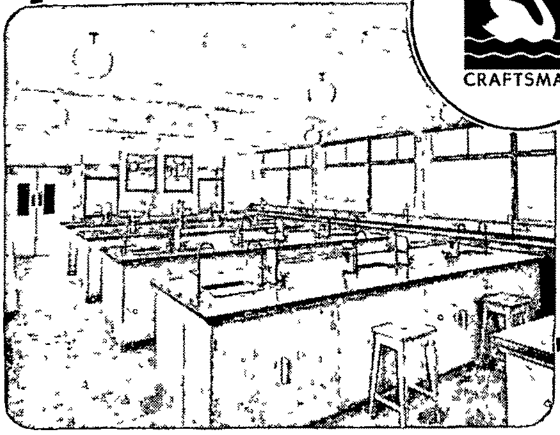
CYGNET

LABORATORY FURNITURE

"CYGNET" Benches, with heat and acid-resisting tops, Racks, Fume Cupboards, Cabinets and Shelving are made in a large range of standard units or to specification Complete installations or single pieces for Industrial, School and College Laboratories at keen prices Built to meet the most exacting demands

●





THE MARK OF THE CRAFTSMAN

Recent contracts include installations for
Scottish Oils Limited
University of Sheffield
British Nylon Spinners, Pontypool
Revertex Ltd, Harlow, Essex
De Havilland Aircraft Co
University of Manchester
Ferranti Limited, Edinburgh.
Gt Lever School, Bolton
Northern Ireland Hospital Authority, Belfast.

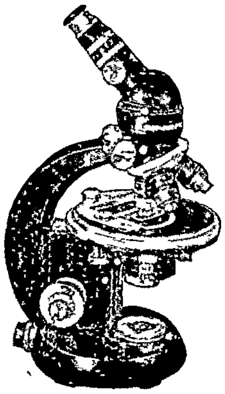
Experience enables us to recommend "FIBROLENE" chemical resistant flooring for laboratories
Send for full details now

CYGNET JOINERY LTD, Higher Swan Lane, BOLTON Bolton 1840/4
Scottish Agents Scottish Instrument Co, Ltd, 4-7 Teviot Place, Edinburgh 1. *Tel* BYPass 3552

ZEISS WINKEL

Polarising Microscope

The refinements of the Winkel Standard design, the built-in illumination, the precision and safety device of the objectives are made available for users of polarising microscopes A full range of accessories is available

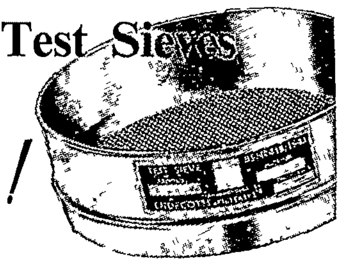


Full details from
DEGENHARDT & CO., LTD.
32 MADDOX STREET, LONDON, W 1
Telephone MAYfair 6639
SOLE IMPORTERS FOR GT BRITAIN & N IRELAND

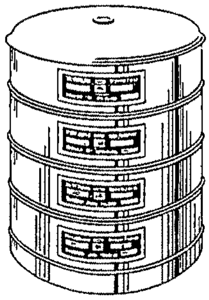
ENDECOTT'S

Standard Test Sieves

for Accuracy!



To B S S or American Standards



Accurate sampling or testing is essential and Endecott's Test Sieves are *guaranteed* to conform to specification The patent sieve body contains no crevices or blind spots to impair test efficiency Durability is assured by attachment of the wirecloth direct to sieve frame, giving uniform tautness and long life Standard sizes are available *from stock*, special requirements can be satisfied promptly

X Test Sieve Vibrators
Pocket Interchanger Sieves
Write for literature X

ENDECOTT'S (FILTERS) LTD

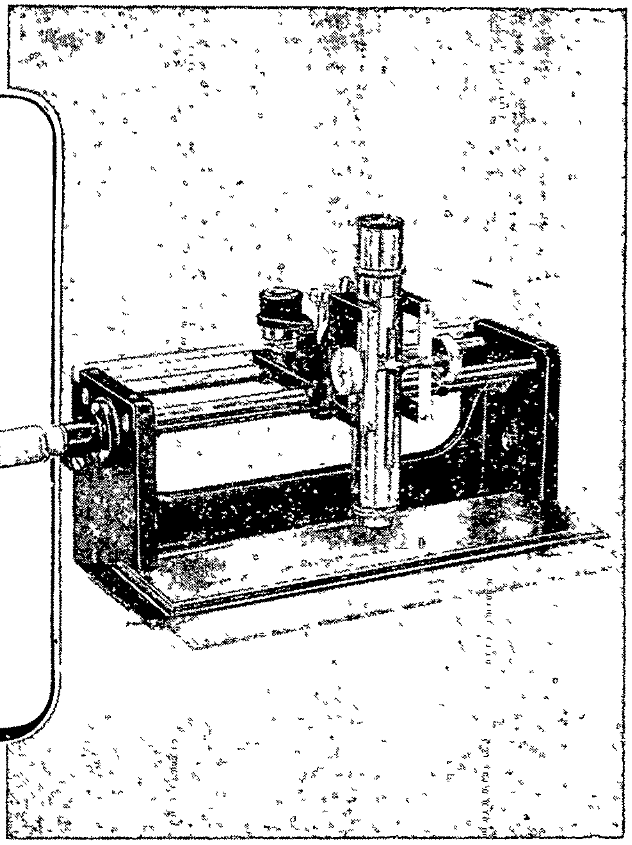
251, Kingston Road, London, S W 19 Liberty 8121/2

"UTILEX" VERNIER MICROSCOPE

with range of 200 mm, reading to 0 01 mm by vernier Fine adjustment screw has micrometer reading to 0 01 mm.

Can be used as Cathetometer

JAMES SWIFT & SON LTD.
113–115a Camberwell Road, London, S.E.5
Telephone · RODney 5441



Leslie Dixon & Co.

SPECIALISTS IN LABORATORY AND TEST GEAR

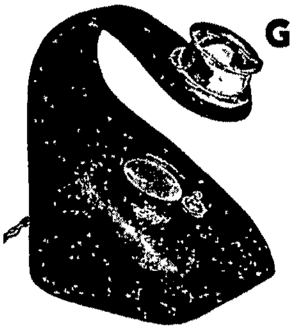
Designed and made to specification Lab tested and guaranteed

NIFE BATTERIES for long life and durability 12 volts, 45 a h comprising ten 1 2 volt cells, in wood crate, **£12 10s**, carr 10s, or single 1 2 volt, 45 a h cells, **30s**, post 2s

B C 221 FREQUENCY METER Accuracy guaranteed 0 005 per cent, frequency range 120 kc/s to 20 Mc/s Battery model, complete with charts and crystal, new condition

PRECISION TEMPERATURE CONTROL OVENS for Quartz Crystals, 230 volts, 50 cycles, will give stability with suitable Crystals of better than two parts in one million Fitted precision thermostat and thermometer Temp adjustable 40/60 degrees cent **£9 10s**, carr 5s

Dept M, 214 Queenstown Road, Battersea, London, S W 8
Telephone MACaulay 2159



GLASSWORKERS' STRAIN-VIEWING POLARISCOPE

Full wave retardation analyser for 5800 A gives most sensitive colour indication of strain Field and sight aperture 1¼" dia Dimensions 6¼" × 5½" × 5" Price **£11 16s 6d**

As above but without colour analyser showing strains against black field Price **£4 15s 0d**

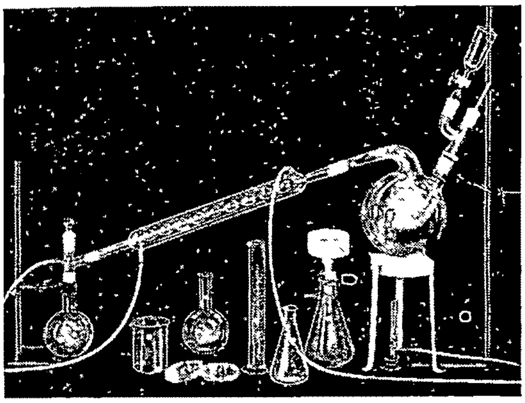
Immediate Delivery

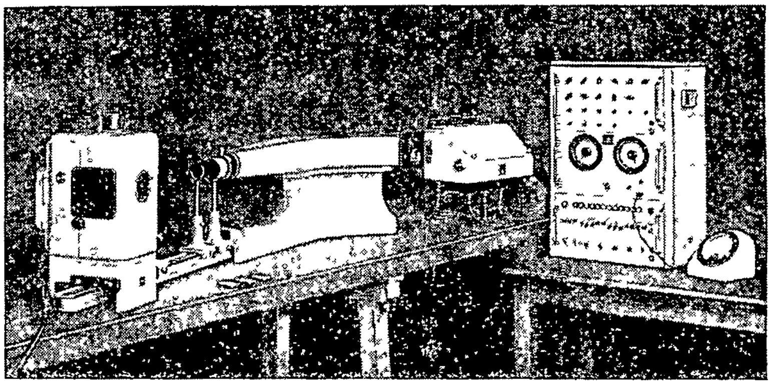
H. S. B. MEAKIN, LTD., 36, Victoria Street, S.W.1
SUPPLIERS OF POLAROID PLASTIC and GLASS Tel Abbey 6713

Glass apparatus to your specification

Your general Laboratory Glassware and Requisites

THE SCIENTIFIC GLASSBLOWING CO. LTD.
95, GRAY'S INN ROAD, LONDON, W.C.1
Telephone HOLBORN 4228





DIRECT READING Spectrochemical Analysis

●

Up to Ten Elements can be quickly and accurately analysed with the Direct Reading Attachment to the Hilger Medium Quartz Spectrograph

The plateholder of the spectrograph is replaced by a unit which will accommodate eleven photomultipliers and slits adjusted accurately on appropriate spectral lines A complete analysis takes under three minutes

Extensive tests have shown that sensitivity is high and reproducibility often better than is obtained with photographic methods

A new design of arc and spark stand ensures that samples are aligned rapidly and precisely Either pencil electrodes or flat specimens can be examined with equal ease

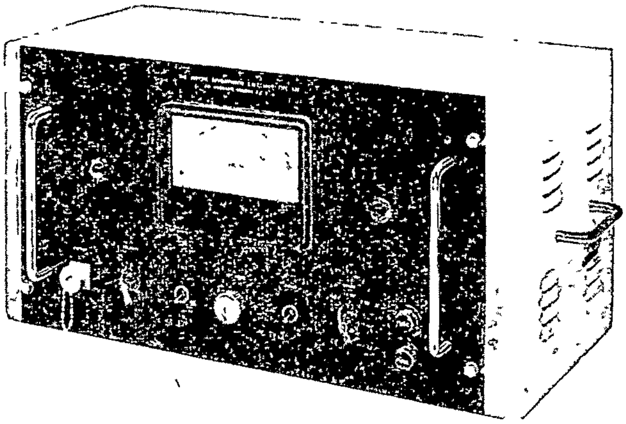
Provision is made for compensating for variations of temperature

The attachment has been used in determining the composition of aluminium, lead, magnesium and other alloys. Results of tests carried out in the Hilger laboratories will be forwarded on request.

Please write for Hilger catalogue CH 383 (*N* 1) *for description of the instrument and CH* 392 (*N* 1) *for applications and results*

HILGER & WATTS LTD.
HILGER DIVISION
98 St. Pancras Way, Camden Road
London, N.W.1, England

Member of the Scientific Instrument Manufacturers' Association and of SCIEX



The Isotope E.H.T. SUPPLY UNIT Type 532

is available immediately

from stock. *This standard Isotope unit, designed for nucleonics but suitable for many electronic requirements, has EXTREME STABILITY (0.02% for 10% change in mains input voltage), drift less than 0 02% per 24 hours, HIGH CURRENT OUTPUT (3-4 mA), E H T. FROM 300-3000 VOLTS (negative and positive polarity)*

ISOTOPE DEVELOPMENTS LTD.

Detailed specifications of all Isotope nucleonic equipment is available on request

120 MOORGATE · LONDON · E.C.2

Telephone METropolitan 9641 (5 lines)

●*Midland Agent* **HAWNT & CO. LTD.**
59, Moor Street
BIRMINGHAM, 4
Tel CENTRAL 6871

Northern Agent **A. M LOCK & CO LTD.**
Crompton Street, Chadderton
OLDHAM, LANCS
Tel MAIN 6744

Scottish Agent **A. R. BOLTON & CO.**
72, Haymarket Terrace
EDINBURGH, 12
Tel EDINBURGH 62446

emphasis has shifted towards the transonic and supersonic speed-range In hydrodynamics the St Lawrence Seaway project became a major interest, and a 1/30 scale model of one of the navigation locks was being used for determining the effect of the spacing of the filling ports and valve-opening schedules upon the rate of filling of the lock and upon variations in the water surface Gas turbines absorbed the major effort in thermodynamics, and a system of thrust boosting for aircraft jet engines by exhaust reheat was being developed in which most of the additional fuel is injected before the turbine The influence of fuel composition, antioxidants, drum materials and other factors on the rate of deterioration of fuels in storage was being investigated, and a theoretical analysis of the stiffness and optimum weight-stiffness of tubes with inclined ribs showed that true optimum weight-bending stiffness configurations exist in the conventional wing range of aircraft structures, but that for torsion the optimum condition is beyond applicable limits

Much of the work of the Radio and Electrical Engineering Division has continued to be on defence projects, but a microwave position-fixing system for vessels engaged in offshore survey operations has been developed and constructed, as well as a microwave link for remote control of isolated fog-alarm stations, and a wired-television link with a remotely controlled camera mounted in a submersible cylinder which permits surface operators to study aquatic flora and fauna, bottom details, wharf pilings, hulls, etc , to depths of a hundred feet A new merchant-marine radar set with improved performance in both short-range definition and long-range detection has also been developed, while studies of semiconductors have led to an understanding of the operation of a crystal rectifier at high voltage An improved antenna has been developed for use with domestic television receivers as well as a highly accurate frequency-measuring attachment for radio receivers and also a combined electro-phono-cardiograph which presents simultaneously on the screen of a cathode-ray oscillograph the wave forms of the electrical impulses from the heart together with those of the sounds due to heart motion A new type of mass spectrometer, the 'omegatron', for determining the constituents of gas mixtures, has been designed and built.

Most of the 136 grants-in-aid made by the Division of Medical Research were in the basic medical sciences, about two-thirds being for a continuation of previous studies Some grants for experimental studies in pathology and surgery indicate an interest in the cause and nature of disease and in physical methods of treatment

---

EXPERIMENTAL INVESTIGATION OF LEAF FORMATION, SYMMETRY AND ORIENTATION IN FERNS

By Prof C W. WARDLAW
Department of Cryptogamic Botany, University of Manchester

INVESTIGATIONS of the inception and development of leaf primordia in *Dryopteris austriaca* have yielded the following information. (Primordia are referred to as P_1, P_2, P_3, etc , P_1 being the youngest visible primordium , I_1 indicates the site of the next primordium to be formed and I_2 the next after that The tetrahedral cell at the tip or summit of the shoot and its recently formed segments are referred to as the 'apical cell group')

(i) Leaf primordia are always formed on an apical meristem

(ii) A leaf primordium typically originates near the base of the apical cone It consists of a circular to elliptical group of the distinctive, superficial prism-shaped cells of the apical meristem, which grows out, forming a low mound of tissue , the small-celled tissue within is also in a state of active division

(iii) A young primordium, situated between and above two older ones, occupies only a small part of the free surface of the apical cone.

(iv) On further development, an approximately central, superficial cell of the primordium now becomes much enlarged During this process, this 'leaf apical cell' acquires its characteristic 'two-sided' shape, its orientation being such that the segments produced by its division lie in the tangential plane. These give rise to the marginal meristems from which the tissues of the primordium are formed.

(v) The alignment of the leaf apical cell and of its partition walls at cell division is thus at right-angles to the principal direction of growth in the subtending apical cone, that is, the tangential direction , and it may well be that the shape and disposition of the leaf apical cell are directly attributable to the relatively large tangential component of growth in the leaf site. Once the two-sided apical cell has been established, the foliar nature of the primordium is irreversibly determined

(vi) In relation to the position in which a leaf primordium originates, that is, on the side of a cone, growth on its abaxial side is more rapid than on its adaxial side , and this difference soon becomes accentuated as the primordium passes into the actively growing and rapidly widening subapical region of the shoot (Fig 1). It thus appears that the

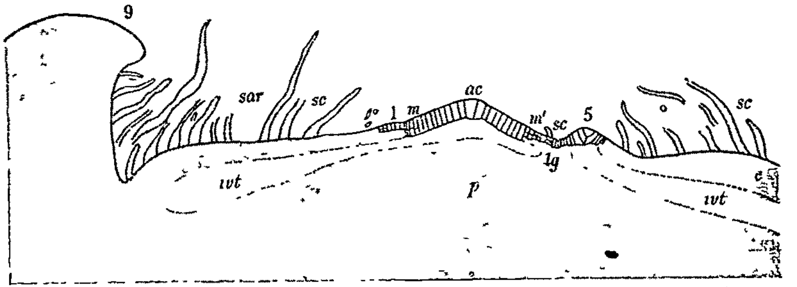


Fig 1 *Dryopteris austriaca*, the apical cone as seen in median longitudinal section, traversing the youngest visible primordium (1) and older ones (5, 9) The apical cell, *ac*, and the distinctive prism-shaped cells of the apical meristem *m–m′* are shown *sc*, scale , *c*, cortex , *p*, pith , *ivt*, incipient vascular tissue , *lg*, leaf-gap , *sar*, sub-apical region (Semi-diagrammatic × 30)

orientation, dorsiventral symmetry and shape of a developing primordium may be referred to the growth activity of the region of the shoot apex in which it originates and to the disposition and activity of its own apical and marginal meristems

(vii) While a primordium still forms part of the apical cone, its growth is relatively slow, but once it is in the subapical region, its growth and morphological development are rapid The sooner a primordium comes to occupy a subapical position, that is, as a result of the growth of the shoot apex, the more rapid will be its enlargement and morphological elaboration Thus, a P_3 primordium on a small apex of low phyllotaxis is larger and more elaborate than a P_3 on a large apex of high phyllotaxis

(viii) The actual inception of leaf primordia is an obscure and complex phenomenon In ferns, the indications are that a primordium is formed at a growth centre, that is, a locus of special metabolism The position of this centre is apparently controlled by the apical cell group at the summit of the shoot and by the two adjacent primordia of the top whorl The growth centre consists of a circular group of seven to nine meristem cells in which we may suppose there is an accumulation of the substances that determine the outgrowth of a lateral organ

On the basis of experimental observations, I have already attempted[1] to relate leaf symmetry and orientation in ferns to the position in which the primordium originates, and to possible inhibitive effects proceeding basipetally from the apical cell group Thus it was shown that if the I_1 position is isolated from the upper part of the apical meristem by a deep tangential incision, a bud, and not a leaf, is formed In general terms it was thought that, as a result of this operation, inhibitive effects from the apical cell group would be precluded, and a levelling up of the growth-rates on the adaxial and abaxial sides of the primordium might take place If so, the development of a radially symmetrical organ, that is, a shoot bud, might be expected Cutter[2] has since shown that if P_1 and P_2 are similarly isolated before the characteristic two-sided initial cell has been formed, they, too, can be transformed into buds, and Wardlaw and Cutter[3] have shown that the prevascular tissue, which immediately underlies the prism-shaped cells of the meristem, is important in these several morphogenetic developments

In some recent experiments an attempt has been made to ascertain whether the dorsiventral symmetry and orientation of leaf primordia can be attributed (*a*) to a specific localized effect, on the adaxial side of the primordium, of an inhibiting substance proceeding from the apical cell group, or (*b*) to the regulated growth which is characteristic of the intact shoot apex as a whole. In relation to (*b*), it may be noted that there is a steady acceleration in the rate of growth from the apex to the base of the apical cone, and a rapid acceleration of growth in the region of transition from the base of the cone to the sub-apical region (Fig 1) Primordia originate near the base of the cone and are soon affected by this active region of transition Wide and deep tangential incisions above P_1 and I_1, whereby the formation of buds can be induced, would evidently preclude (*a*) and cause serious disturbances to (*b*) Here it is relevant to note that when bud formation is induced in a leaf site, for example, at I_1, or by the transformation of a leaf primordium, for example, P_1, the bud not only quickly develops a large apical meristem but also shows strong growth on its adaxial side.

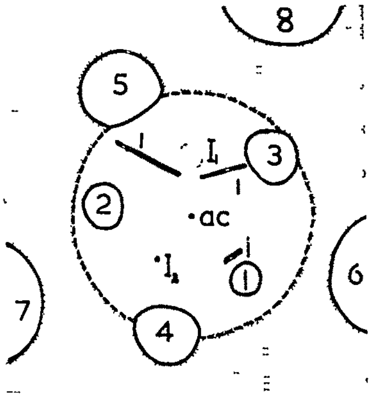


Fig 2 *Dryopteris austriaca* Apex as seen from above, showing leaf primordia 1–8 and the positions of I_1, the next primordium to be formed, I_2, the next after I_1, and the apical cell *ac* A small deep incision, *i*, has been made on the adaxial side of P_1 Two wide and deep tangential incisions, *i*, *i*, have been made above I_1 so as to leave a 'bridge' of intact tissue between the primordium site and the apical cell The sub-apical region is stippled

Of a considerable and varied series of new surgical experiments which have now been carried out, the two most directly relevant to the problems of leaf and bud formation are illustrated diagrammatically in Fig. 2 In one series, small deep tangential incisions, severing the incipient vascular tissue, were made immediately above I_1, I_2, P_1 and P_2 If dorsiventrality in a primordium is due to a limitation of the growth-rate on its adaxial side, that is, as a result of the basipetal movement of a growth-regulating substance from the apical cell group, some bud formation might be expected in this experiment In the other series, two deep and extensive tangential incisions were made just above a primordium (or primordium site), so as to leave a 'bridge' of intact tissue between it and the apical cell group If dorsiventrality is mainly due to a localized (adaxial) inhibitional effect proceeding from the apical cell group, then leaves should still be formed, but if it is a result of the regulated growth of the apex as a whole (or of the sector in which the primordium is situated), then, in relation to the extensive restriction of both the acropetal and basipetal movement of metabolic substances by the tangential incisions, and the consequential radical disturbance of the normal distribution of growth in the apical cone, some bud formation might well be expected.

The results of these two experiments are set out in Tables 1 and 2, the records relating to specimens in which the apical cell group remained intact and quite undamaged (These experiments are of some delicacy and not easy to perform successfully)

The evidence from the first set of experiments (Table 1) is conclusive small adaxial incisions have in no instance resulted in bud formation It thus appears that the dorsiventrality of leaves cannot be attributed to the localized action of a growth-regulating substance on the developing primordium

The evidence from the second series, though less conclusive, is none the less important In at least some apices (actually 25 per cent of all primordia and 40 per cent of I_1's), bud formation can be induced when the apical cell is undamaged and when intact tissue extends between it and the primordium (Fig 3) In those apices in which buds were formed, the experimental region was marked by very con-

Table 1 EFFECT OF SMALL ADAXIAL INCISIONS

Primordium	Leaf formed	Bud formed	No development
I_2	2	—	—
I_1	6	—	2
P_1	9	—	1
P_2	3	—	—
Total	20	0	3

Note In other specimens, in which the shoot apex had accidentally been slightly damaged, 13 leaves and 6 buds were obtained

Table 2 TANGENTIAL INCISIONS WITH INTACT BRIDGE

Primordium	Leaf formed	Bud formed	No development
I_2	3	—	—
I_1	7	5	3
P_1	9	2	1
P_2	1	1	—
Total	20	8	4

Note Where the 'bridge' had been eliminated, that is, by the two incisions joining up, or where the shoot apex had been damaged, even very slightly, buds were usually formed Where the 'bridge' was wide, leaves were usually obtained, though occasionally a bud was formed

spicuous growth activity and the buds were of large size (Fig 3). Late-season apices, which were relatively inactive, typically yielded leaves

Where buds were obtained, as in Fig 3, microtome sections showed that the bud was in vascular continuity with the parent shoot in the region of the 'bridge'

In the light of these experimental results, to what factors and relationships may the organization of the fern apex and its orderly morphogenetic activity be attributed?

There is considerable support for the view that the apical cell group is a region of special metabolism, as is also each growth centre which may become a leaf, or, if subjected to experimental treatment, a bud. Products of the metabolism of the apical cell group, moving basipetally by way of the prevascular tissue, may exercise a regulative effect on the growth of the apical and sub-apical regions Thus, in the upper part of the apex, where the concentration of the growth-regulating substance will be high, the rate of growth of the meristem cells may be kept low, but lower down, and in the region of transition to the sub-apical region, where the concentration of the growth-regulating substance will be much lower, growth may be promoted. This hypothetical substance, which might be an auxin or hormone, or a precursor of one or other of these, is likely to be essential in some way to protein synthesis, as Skoog[4] has recently suggested An important feature of this conception is that the substance will produce its organizing and morphogenetic effects by the way it affects the growth of individual cells, each of which will react in a characteristic way according to its physiological state, rather than by its action on primordia as such

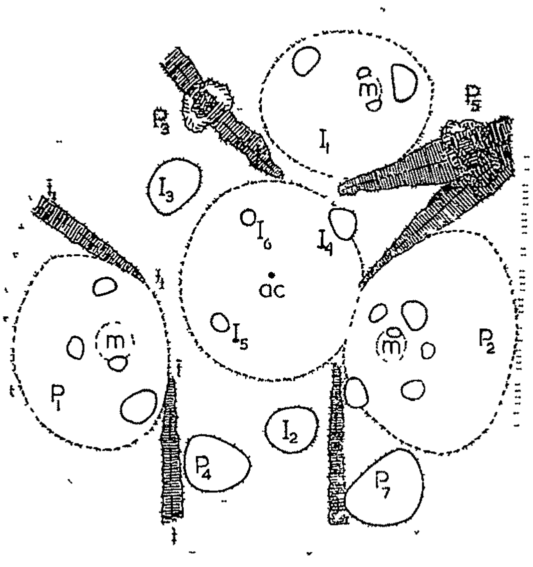


Fig 3 *Dryopteris austriaca* Apex, as seen from above, showing the large buds which have been induced in the I_1, P_1 and P_2 positions when these positions were partially isolated from the shoot apical cell by two wide tangential incisions In each instance a 'bridge' of intact tissue was present on the adaxial side of the primordium *ac*, position of the apical cell of the main apex P_1–P_7, primordia present at the beginning of the experiment, P_1 and P_2 having been transformed into large buds The locus of I_1 has also developed into a large bud ii–i_1i_1, tangential incisions I_2–I_6, new leaf primordia formed during the course of the experiment *m*, apical meristem of induced buds The broken lines indicate approximately the bases of the main apex and of the buds (Diagrammatic camera lucida tracing, × 15)

An alternative view might take the form that the apical cell group is not a locus of special metabolism, the organization of the apex being due to competition among its constituent cells for the nutrients involved in growth As these nutrients move acropetally from the older regions below, with differential utilization of the several substances at different levels *en route*, the supply will diminish progressively and change qualitatively as the shoot tip is approached

The most satisfying explanation, however, probably lies in a combination of the two views Thus destruction or isolation of the shoot tip would simultaneously remove both its regulative and competitive activities In the 'bridge' experiment described above, the two wide tangential cuts go a long way towards isolating the shoot tip, and, as we have seen, marked growth activity may be induced on the adaxial side of primordia and buds may be formed On the other hand, as even a cursory inspection will show, a small incision above a primordium will do little to modify the normal movement of metabolites As rapid wound-healing, with formation of parenchyma and an outgrowth of scales, takes place at the injured tip and in proximity to incisions, it is evident that both the quantity and quality of the nutrients being drawn upwards are different from those normally utilized in the growth of meristem cells Scale and parenchyma formation, indeed, are characteristic of the normal growth developments on the abaxial side of actively developing primordia. Furthermore, in apices with a damaged tip, young primordia, already determined as leaves, may be observed facing and curving outwards instead of inwards, in relation to the high rate of growth on the adaxial side

In conclusion, it may be noted that in the ferns the apical cell is the focal point in the distal meristem and is essential for the continuing growth of the shoot. It may also be regarded as the ultimate determiner of the orientation and symmetry of leaf primordia. But such effects are apparently not produced by its direct action but are mediated through the organization and physiological activity of the apex as a whole

---

[1] Wardlaw, C W, *Growth* (Supp), 13, 93 (1949)

[2] Cutter, E G, *Nature*, 173, 440 (1954)

[3] Wardlaw, C W, and Cutter, E G, *Nature*, 174, 734 (1954)

[4] Skoog, F, Brookhaven Symp Biology, 6, 1 (1954)

A NEW ABSOLUTE HYGROMETER OF HIGH ACCURACY

By DR. R G WYLIE

Division of Physics, National Standards Laboratory, Commonwealth Scientific and Industrial Research . Organization, Sydney

THE history of hygrometry, especially during the past few decades, has been characterized by a continual searching for new methods which do not suffer from the shortcomings of inaccuracy, slow response or general inconvenience encountered with the classical methods Probably the most important developments which have resulted are the electrolytic method of Dunmore[1] and the 'Dewcel' described by Hickes[2], both of which have been successfully applied in particular fields These methods involve the construction of relatively complex and expensive sensitive elements

Dunmore's elements, and somewhat similar types developed since, suffer from the disadvantage that their humidity – resistance relationship is empirical and subject to change with time and especially with exposure to extreme conditions The 'Dewcel' method is limited in accuracy by the fact that the electrode wires occupy an appreciable fraction of the surface area of an element, and by changes which occur in the electrolytic medium The error of a 'Dewcel' can be determined only by comparison with an independent hygrometer

No convenient method of hygrometry has yet been reported which can approach the accuracy of the dew-point method

The dew-point method itself suffers from a number of disadvantages, notably that the visual instruments are slow and tedious to use and that the presence of contamination on the dew-condensing surface can give rise to unsuspected errors On account of the way in which condensation and evaporation occur, and because of the operator's desire to achieve the best accuracy, the tendency, both with visual instruments and with automatic instruments in which the condensing surface is examined by photoelectric or equivalent means, is to work with the smallest possible quantity of dew The effects of contamination will then be greatest In fact, during condensation on a polished surface, the amount of light scattered by the deposit increases only during the earliest stages, associated, in most cases, with the dissolving of minute quantities of soluble matter and the dilution of the consequent solution Only an instrument in which equilibrium can be established between pure phases can yield results which are independent of the mechanism of the phase change and hence which are accurately reproducible

The method to be described here is absolute in the same sense as the dew-point method, and is more accurate and more amenable to instrumentation.

The principle is simple and is derived from the fact that water vapour is taken up by the surface of a water-soluble crystal if the water-vapour pressure is greater than the vapour pressure of a saturated solution of the crystalline substance at the temperature of the crystal surface This gives rise to a layer of saturated solution on the surface of the crystal, and for any soluble crystal surrounded by moist gas of constant composition a critical temperature exists at which the surface layer is in equilibrium with its surroundings If the crystal is ionic, the presence of this layer, as well as changes in its thickness, can readily be detected by electrica methods. By raising or lowering the temperature of the system the critical temperature can be determined with great precision, since the electrical resistance of the layer, which is too thin to flow, will remain constant at that temperature The partial pressure of the water vapour in the gas surrounding the crystal can then be deduced from a knowledge of the vapour pressure of the saturated solution of the salt as a function of temperature

If a temperature which is slightly higher than the critical value is maintained, the electrical resistance between suitable electrodes making contact with the crystal surface will increase steadily until a very high value is reached which is related to the adsorption of water at the surface If a temperature which is slightly lower than the critical value is maintained, the resistance will decrease steadily until the ionic substance is excessively dissolved If the surface of a pure ionic crystal is clean, the actual value of the electrical resistance, the constancy of which indicates that the critical temperature has been established, may be chosen arbitrarily within a very wide range For example, using a crystal of potassium chloride of cubic form, it has been found that for resistances measured between opposite faces of the crystal, of less than 0 05 to more than 5 megohms, the equilibrium temperature is constant within the accuracy of the best measurements made, namely, ± 0 01 deg C

Laboratory Evaluation of the Method

The practicability and accuracy of the method were first demonstrated by the following simple experiment Atmospheric air was brought into water-vapour equilibrium with saturated sodium thiosulphate ('hypo') solution by bubbling it slowly through a tube containing a slightly undersaturated solution of 'hypo' and then passing it through a tower containing moist 'hypo' crystals , this was done in a stirred Dewar vessel at room temperature

The air was then brought to the temperature of the stirred water in a second Dewar vessel by passing it through a glass coil immersed in the water Thence it passed through a glass tube, also immersed in the second vessel, in which an approximately cubic single crystal of 'hypo' was held between two parallel graphite plates each approximately 2 mm square The electrical conductance between the crystal supports was measured using a direct-reading electronic unit of simple design which passed a 50 c /s alternating current of about 5 μamp between the electrodes when the resistance was about 0 5 megohm The sensitivity was such that a resistance change of 1 per cent was easily detected

By adding a few drops of either warm or cool water to the Dewar vessel containing the crystal unit, the temperatures in the flasks, which were measured with mercury-in-glass thermometers, could be equalized at approximately room temperature or caused to differ slightly either way By interchanging the thermometers during an experiment, their separate calibration was rendered unnecessary

Using the criterion that the resistance should be constant at some value in the range of 0 5–2 megohms it was found that the temperatures could be equalized repeatedly as accurately as the thermometers could be read Since the thermometers were similar and were divided to 0 05 deg C, temperature equality to ± 0 01 deg was therefore proved, thus establishing that the principle could serve as a basis for precise hygrometry

Practical Form of the Hygrometer

A satisfactory form of the hygrometer is a small isothermal metal enclosure, about an inch long and an inch in diameter, in which a suitable ionic crystal is mounted on two chemically inert electrodes. The gas, the humidity of which is to be measured, is allowed to fill the enclosed space, which is cooled or heated as the case may require until the critical temperature is reached. If the gas is to be passed continuously through the enclosure, as will often be the case, it must be brought to the temperature of the enveloping metal before it is admitted This may be achieved by first passing the gas through channels cut in the piece of metal or through an attached coil of metal tube

The enclosure may be cooled by the passage of a refrigerant through appropriate channels Carbon dioxide expanded at a small needle valve from cylinder pressure to atmospheric pressure may be used as a clean and easily regulated refrigerant Heat may be provided electrically using a resistance winding of insulated wire wound directly on the metal For very rapid response and for accuracy it is an advantage to measure the temperature of the metal enclosure with a resistance thermometer wound directly on to it or with a directly attached thermocouple

The crystalline substance should be in the form of a single crystal or a transparent group of crystals, a group containing many fissures will slowly take up or liberate relatively large amounts of water Crystals suitable for most purposes include potassium sulphate, sodium chloride, calcium chloride and lithium chloride, which possess equilibrium relative humidities of approximately 99, 76, 30 and 15 per cent, respectively With potassium sulphate, for example, cooling will generally be necessary, whereas with lithium chloride heating is necessary except for relative humidities less than about 15 per cent, reckoned at ambient temperature Although used for convenience in the initial experiments, sodium thiosulphate is not an ideal choice since it reacts sensitively with acid vapour and even carbon dioxide

For manual operation the conductivity may be indicated directly on a deflecting instrument For automatic operation the resistance of the crystal may be made, by electronic means, to govern the heating or cooling of the metal enclosure Any such automatic system contains a perfect integrating link on account of the condensation process and must, therefore, give the true equilibrium temperature, however, the design must ensure that, for the maximum amplification consistent with stability, the response of the system is sufficiently rapid

A hygrometer constructed in accordance with the above principles has been used with crystals of a number of salts Experience with this instrument has shown that the method is reliable, accurate and rapid When the equilibrium temperature is already known approximately, the time required to obtain a balance to ± 0 01 deg C is about one minute. The vapour pressures of saturated salt solutions are, however, not in general known at present with an accuracy higher than the equivalent of ± 0 1 deg It should be mentioned that an accuracy of ± 0 01 deg, corresponding approximately to ± 0 1 per cent relative humidity, can be utilized fully only when the departure of the behaviour of a mixture of air and water vapour from the laws for a perfect gas mixture is taken into account

Surface contamination of the crystal has not been found to be a serious problem If present, it can readily be detected and its effect on the measurement eliminated by observing the balance temperatures for two widely different values of the resistance of the crystal unit and extrapolating to zero resistance Soluble surface contamination which has not originated from impurities in the crystal substance is easily removed with water

In some cases small jumps in the resistance, which probably resulted from electrode effects, have been observed Any effects due to electrode phenomena can be eliminated by using four contacts on the crystal, representing current and potential connexions, or by using high-frequency methods with two electrodes spaced from the crystal For most purposes the use of such methods is unlikely to be necessary

Applications

The method provides a convenient substitute for the dew-point hygrometer It is more accurate and more amenable to instrumentation In contrast with the dew-point method, it allows accidental contamination of the surface to be detected easily It is readily applicable to measurements on gases at very high pressures With a crystal of calcium chloride, the useful range is continuous down to −55° C Provided that the gas reaching the hygrometer is of constant composition and that the crystal is reasonably pure and is held by clean, well-formed electrodes, the ultimate accuracy is probably determined by the limitations of precise thermometry

The instrument obviously provides a powerful tool for the accurate measurement of the vapour pressures of saturated salt solutions as a function of temperature It is proposed to use as a standard substance potassium sulphate, the saturated solution of which provides a relative humidity of about 99 per cent, and work is in progress to determine accurately the vapour pressure – temperature relationship of a saturated solution of this substance relative to the vapour pressure of water It is intended then to determine the vapour pressure curves for a number of stable salts, using each in turn for the hygrometer crystal element

The method will be used for providing the standard of reference for the testing of hygrometers at the National Standards Laboratory in Sydney Work is at present in progress on a rapid automatic instrument to be used as the humidity-sensitive unit for the accurate control of atmospheres in researches on biological materials in other laboratories of the Organization

A detailed account of the hygrometer will be published elsewhere I wish to acknowledge the work of Mr W van Peer in constructing the electronic resistance-measuring unit and in assisting with the experiments

---

[1] Dunmore, F W, *U S Nat Bur Stand J Res*, **20**, 723 (1938), **23**, 701 (1939)

[2] Hickes, W F, *Refrig Eng*, **54**, 351 (1947)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications

Specificity of Creatine Phosphokinase

SOME of the properties of the enzyme creatine phosphokinase have recently been described[1], but no experiments were reported on the activity of the enzyme with substrates other than adenosine triphosphate, adenosine diphosphate, phosphocreatine and creatine Such experiments are in progress and will be reported in due course A recent publication by Armstrong[2], in which it was shown that the administration of N-ethylglycocyamine (negmine) was followed by the urinary excretion of N-ethylglycocyamidine (negmidine), suggested that a phosphorylation reaction may have been involved It was therefore of interest to determine whether negmine could be phosphorylated by the creatine phosphokinase system

Some experiments have been carried out with a system similar to that already described[1] for the reaction

$$\text{ATP} + \text{creatine} \rightarrow \text{PC} + \text{ADP},$$

but differing in that negmine was substituted for creatine and the temperature was controlled at 30° The course of the reaction was followed by removal of samples at various time-intervals after the addition of adenosine triphosphate to the system, and determinations of negmine were made by the same method as that used for creatine[1]

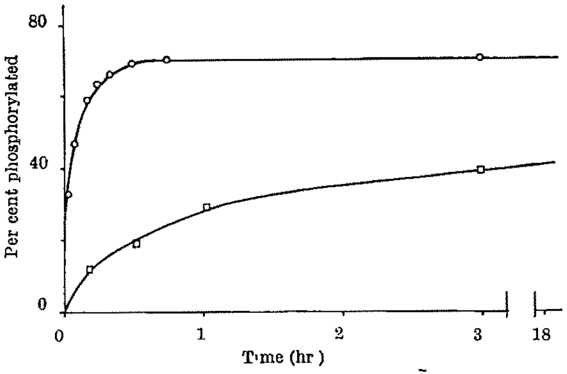


Fig 1 Rate of phosphorylation of creatine (○—○) and negmine (□—□) by the creatine phosphokinase – adenosine triphosphate system

It will be noted that negmine was phosphorylated, but at a much slower rate than was creatine On the other hand, the amounts of each which were phosphorylated in the maximum time-interval investigated (18 hr) were not greatly dissimilar

The product of the reaction, phosphonegmine, was not isolated, but its properties (Table 1) are similar to those of phosphocreatine in the ease with which it may be hydrolysed under mild conditions (9 min, 0 1 *N* hydrochloric acid, 65°) It will also be noted that, as with creatine, there is an almost quantitative recovery of negmine following hydrolysis.

Table 1 RECOVERY OF CREATINE AND NEGMINE BY HYDROLYSI FOR 9 MIN AT 65° IN 0 1 *N* HYDROCHLORIC ACID AFTER REACTIO WITH CREATINE PHOSPHOKINASE – ADENOSINE TRIPHOSPHATE FO 18 HR

	Initial	Final (18 hr)	Final (after hydrolysis)
Creatine (μmoles)	20 0	7 2	19 6
Negmine (μmoles)	20 0	8 0	19 6

The fact that negmine may be phosphorylated by the creatine phosphokinase – adenosine triphosphate system is of importance, for, since the administration of glycocyamine is not followed by the excretion of glycocyamidine, and since glycocyamine is not phosphorylated by this system[3], it may be inferred tha creatinine does arise from phosphocreatine[4,5]. Thi does not, however, provide proof of the hypothesis that creatinine arises as a result of the non-enzymi breakdown of phosphocreatine The results als confirm the belief[2] that the urinary excretion o negmidine followed the *in vivo* formation of phospho negmine.

The complete results of this investigation will b reported in greater detail elsewhere

A H ENNOR
H ROSENBERG

Department of Biochemistry,
John Curtin School of Medical Research,
Australian National University,
Canberra

M D ARMSTRONG

Laboratory for the Study of
Hereditary and Metabolic Disorders,
College of Medicine,
University of Utah,
Salt Lake City 1
Sept 23

[1] Ennor, A H, and Rosenberg, H, *Biochem J*, 57, 203 (1954)

[2] Armstrong, M D, *Fed Proc*, 12, 170 (1953)

[3] Ennor, A H, and Rosenberg, H (unpublished observations)

[4] Lipmann, F, "Adv in Enzymol", 1, 99 (1941)

[5] Borsook, H, and Dubnoff, J W, *J Biol Chem*, 168, 493 (1947)

Mode of Action of Tetanus Toxin

THOUGH the general effects produced by tetanus toxin on the nervous system have been reported by many investigators, there is still no precise evidence as to its mode of action[1] Sherrington[2] pointed out that tetanus toxin closely resembles strychnine in many of its effects, and postulated that both substances convert synaptic inhibition into excitation Recently[3], it has also been found that tetanus toxin resembles strychnine in that the monosynaptic tendon jerk is but little affected by moderate dosage Since it has now been shown that strychnine acts specifically by diminishing all types of synaptic inhibitory action[4,5], it was of interest to investigate the action of tetanus toxin on synaptic inhibition.

The tetanus toxin was administered by injection within the sheath of the sciatic nerve in order that its effect on the spinal cord would initially be localized, and hence control responses would be provided by the other side The procedure for investigating direct inhibition resembled that already described[4], single maximum volleys in the large stretch afferents from quadriceps muscle being employed to inhibit the monosynaptic reflex discharges which were evoked from biceps-semitendinosus motoneurones at varying testing intervals thereafter. In Fig 1 the inhibitory curves so constructed at 21–43 hr after the injection of the toxin give a typical illustration of our experimental findings The earliest test, at 21 hr, revealed that the inhibition amounted to 65 per cent, in

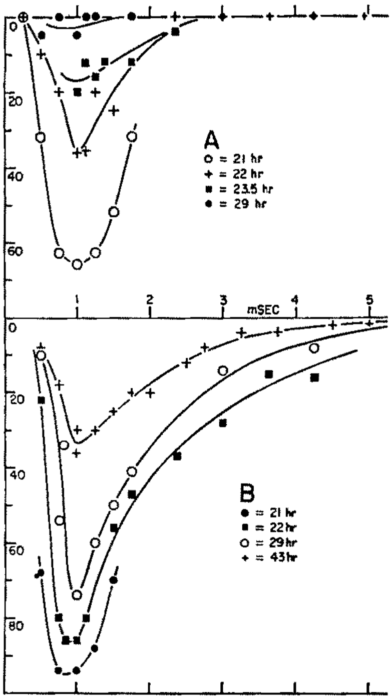


Fig 1 Curves showing time courses of direct inhibition of monosynaptic reflex from biceps-semitendinosus motoneurones of the spinal cat under light 'Nembutal' anæsthesia The symbols denote the inhibitory effects observed at the times indicated after the injection of 7 mgm of tetanus toxin (Wellcome *XB* 1322 *T* 166) in 0 05 ml normal saline under the sheath of the left sciatic nerve at the mid-thigh level Figs 1 *A* and *B* were obtained respectively on the left and right sides The percentages of inhibition of the monosynaptic reflex spike (ordinates) are plotted against the various intervals (in m sec) by which the testing excitatory volley follows the initial inhibitory volley (abscissæ) Each plotted percentage is the mean of ten to twenty observations

contrast to 95 per cent on the contralateral side. Subsequent tests at 22 and 23½ hr. showed the rapid diminution of the inhibition to about 35 and 15 per cent respectively, while it was still little affected on the contralateral side By 29 hr the respective inhibitions were less than 5 per cent and about 75 per cent The slow diminution of the contralateral inhibition was kept under observation until it was only about 35 per cent at 43 hr , while on the ipselateral side all trace of inhibition had disappeared many hours earlier During all this period the testing monosynaptic reflex spike showed little change in size and remained virtually the same on the two sides Thus the experimental series of Fig 1 shows typically that tetanus toxin resembles strychnine in that it selectively suppresses inhibitory action, while synaptic excitatory action is unaffected.

All other types of inhibitory action in the spinal cord have similarly been suppressed by tetanus toxin and strychnine. It has further been found that tetanus toxin has no effect on the synaptic relays that occur on the direct inhibitory pathway[6] and on the antidromic inhibitory pathway[5]. Finally, intracellular recording from motoneurones has indicated that the inhibitory hyperpolarization is suppressed by tetanus toxin, exactly as occurs with strychnine Thus there are two likely explanations of the action of tetanus toxin that, like botulinum toxin, it may prevent the release of the transmitter substance[7] , or that, like strychnine, it may become attached to the subsynaptic inhibitory areas on the motoneuronal membrane, preventing the action thereon of the inhibitory transmitter

Besides acting as a control, the contralateral observations (Fig 1*B*) illustrate the slow spread of the action of tetanus toxin in the spinal cord that has been reported by previous investigators[1-3] Inhibition in the segment rostral to that illustrated in Fig 1 showed much the same slow development of inhibitory depression as in Fig 1*B*, the inhibitory effect being halved at about 30 hr Concurrently with the gradual suppression of inhibitory action, there was a large development of polysynaptic reflexes, similar to that produced by strychnine This effect could be satisfactorily explained by the depression of inhibitory synaptic action on the interneurones of these polysynaptic pathways, that is, tetanus toxin appears to depress inhibitory action on interneurones as well as on motoneurones

It may be concluded that, in confirmation of Sherrington[2] the action of tetanus toxin on the spinal cord closely resembles that of strychnine , but both these substances act, not by converting synaptic inhibition into excitation, but by suppressing all types of synaptic inhibition It is probable that general tetanus is also similarly explained by the general suppression of synaptic inhibitory action as the tetanus toxin spreads throughout the whole nervous system

V B. Brooks
D R Curtis
J. C Eccles

Department of Physiology,
Australian National University,
Canberra
Nov 25

[1] Wright, G Pavling, *Brit Med Bull* 10, 59 (1954)
[2] Sherrington, C S , "The Integrative Action of the Nervous System" (Yale University Press, New Haven, 1906)
[3] Davies, J R , Morgan, R S , Wright, E A , and Wright, G Payling, *Arch Int Physiol* , 62, 248 (1954)
[4] Bradley, K , Easton, D M , and Eccles, J C , *J Physiol* , 122, 474 (1953)
[5] Eccles, J C , Fatt, P , and Koketsu, K , *J Physiol* (in the press)
[6] Eccles, J C , Fatt, P , and Landgren, S , *Aust J Sci* , 16, 130 (1954)
[7] Brooks, V B , *J Physiol* , 123, 501 (1954)

Effect of Background Activity on the Action of Acetylcholine on the Electrical Activity of the Brain

RECENT experiments have led to the suggestion[1] that the physiological action of acetylcholine on the activity of the brain might be conditioned by the state of excitation of the brain itself

As a preliminary test of this possibility, two series of experiments have been carried out on rats, rabbits and cats In the first series, electroencephalograms were recorded from needle electrodes in the intact skull, and acetylcholine was rapidly injected into the internal carotid artery In the second series, a 'Perspex' irrigation chamber was fixed tightly into a trephine hole in the skull, and Ringer–Locke solution—to which acetylcholine could be intermittently added —was passed slowly through the chamber The electroencephalogram was recorded from a fine electrode, insulated to the tip, in contact with the exposed cortex. When administered by either route, to an animal anæsthetized with 'Dial', acetylcholine caused, as was expected, excitation with small doses and depression with larger doses, the threshold dose for excitation being, for intracarotid administration in the rabbit, of the order of 1–2 μgm In irrigation experiments the doses required were higher (25 μgm.

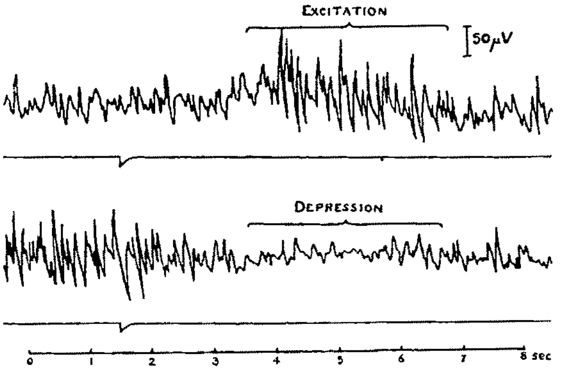


Fig. 1. Electroencephalogram record from exposed irrigated cortex of rabbit. Upper tracing, animal under 'Dial' alone, lower tracing, animal under 'Dial' + leptazol. At signal, acetylcholine (25 μgm.) added to irrigation fluid: excitatory action of acetylcholine on quiescent cortex, depressant effect on activated cortex

for excitation), but the effects were qualitatively similar.

When the cortex of the anæsthetized animal was activated by the intraperitoneal injection of 'Leptazol' (80 mgm./kgm.), doses of acetylcholine which were previously excitatory became inhibitory, a typical result being illustrated in Fig. 1. Doses previously ineffective remained so, while the inhibitory effect of larger doses became less well marked.

The addition of adrenaline (10^{-4} M) to the Ringer–Locke solution irrigating the exposed cortex caused a significant reduction in the threshold dose of acetylcholine required for excitation or inhibition.

None of the effects mentioned could be attributed to the vascular actions of acetylcholine.

This work will be described more fully and discussed elsewhere.

J. Crossland
J. F. Mitchell

Department of Physiology,
University, St. Andrews.
Oct. 1.

---

[1] Crossland, J., *J. Ment. Sci.*, 99, 247 (1953).

Long-term Suppression of a Permeability Response of the Rat's Hind-paw by Cortisone, by Hypophysectomy and by Protein-deficient Diet

Some three years ago, we reported that crude testicular extracts containing hyaluronidase greatly increase permeability in the rat's hind-paw[1]. 0.3–0.8 mgm. of crude extract is dissolved in 0.11 ml. saline and injected at the plantar side; each animal serves as its own control. The acute œdema—surpassing that caused by the usual doses of dextran—contains 4.0–5.5 gm. protein per 100 ml. The presence of histamine was demonstrated by the guinea pig ileum test as well as by partition paper chromatography, the concentration being 2.5–4.5 μgm. per ml. The significance of this histamine, as well as the influence of local reactivity of the tissues of the hind-paw, and the influence of age differences will be discussed separately. We find that young rats regularly show 'full' œdemas in our colony, although the response tends to diminish gradually with advancing age.

In earlier papers[2-4] we dealt with the possibilities of influencing permeability in acute experiments. Pharmacological doses of salicylate, of natural adrenaline, etc., inhibited remarkably the production of œdema. The significance of the presence of the adrenal glands, as well as the importance of circulatory factors, were emphasized.

In the present communication we are dealing with the long-term changes in this permeability response. Each of three groups of experiments relates to 25 animals, or more.

(*a*) Cortisone (subcutaneous) was a potent material inhibiting œdema[5]. The dose necessary to produce full inhibition, however, was remarkably high. About 10 mgm. per 100 gm. for the adult rat and 10–20 mgm. for rats weighing less than 100 gm. was the effective dose if single injections were given. The protection against œdema mostly appeared on the second day, or even later; but it was demonstrable for several days or even a week. The massive dose of 50 mgm. cortisone acetate subcutaneously per 100 gm. rat inhibited œdema induced by testicular extract for a month.

(*b*) A second type of long-term suppression of œdema production of the hind-paw was that of hypophysectomized animals. The time of appearance of this change in permeability response varied; but animals with perfectly evacuated sella mostly failed to react with a sufficient œdema from one to four weeks after the operative procedure until death. It is to be noted that cases were observed with returning response; but hypophysial residue was detected in these cases with the lack of atrophy of endocrine organs. A remarkable lack of permeability response could be thus produced without any hypophysio-adrenocortical activation and/or in the absence of effective amounts of cortisone.

(*c*) As the greatly diminished response of the chronically hypophysectomized rats could certainly not be explained by cortisone action, we searched for a possible common explanation. Alteration of the protein metabolism seemed to be the possible common pathway. The third group of animals, thereafter, consisted of young normals held on a protein-deficient diet containing foodstuffs with the protein content less than 2.0 per cent. No other constituent was restricted. An example of this type of experiment (16/17, five rats) is as follows: body-weight 50–75 gm.; average body-weight decrease after 15 days, 10 per cent.; average caloric intake, 19.9 cal. a day each rat; per cent of protein calories, 9.2. About 15–25 days later the grade of the acute œdema was very slight, if any. All animals were 'hyporeactors' from this point of time, and the response did not return until normal, or protein-rich, diet was introduced. This latter, however, evoked a quick return of the original reaction, that is, within 24–72 hr. More time is needed, however, to restore normal response, if the dietary protein deficiency is maintained for several days. Like the animals of groups (*a*) and (*b*), the growth of these young rats ceases, and a moderate diminution in the body-weight is the rule. The plasma protein concentration did not change significantly.

The present results are not opposed to the possibility that dehydration of the connective tissue (that is, a shift of water from the cells into the extracellular compartment and simultaneous phenomena, including eventually alterations in the metabolism of the cement-substances) may be important in the effects produced by the protein-deficient diet. Based on these observations, the explanation of the influence of pharmacological doses of cortisone, at least that exerted on permeability mechanisms, seems to be in the field of the alterations of protein metabolism and its consequences Similar changes are apparent after hypophysectomy Our results suggest that long-term suppression of permeability is attainable, if the metabolism of water-binding molecules is altered, whereas only transitory suppression results if dehydration is produced without long-term influencing of water-binding macromolecules

Details of these experiments will be published in *Acta Medica Hungarica*

E KELEMEN
B TANOS
L HAJDU
P FORGÁCS

I Belgyógyaszati Clinic,
Szeged, Hungary
Aug 30

[1] Kelemen, E , Majoros, M , and Ivanyi, J , *Acta Med Hungarica*, **2**, 201 (1951)

[2] Tanos, B , Soltész, R , and Kelemen, E , *Acta Med Hungarica*, **4** 419 (1953)

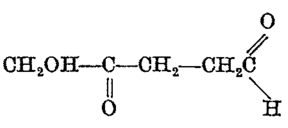
[3] Kelemen, E , Tanos, B , Soltész, R , and Kovacs, K , *Acta Endocrin* , **13**, 231 (1953)

[4] Kelemen, E , *Brit Med J* , ii, 301 (1954)

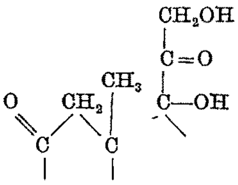
[5] Kelemen, E , Oláh, F , and Majoros, M , *Lancet*, ii, 886 (1951)

A Colorimetric Reaction for the Estimation of Cortisone, Hydrocortisone, Aldosterone and Related Steroids

IT was shown by Stacey *et al* [1] that one of the substances responsible for the development of colour in the Dische reaction[2] for deoxynucleic acid is ω-OH-lævulinic aldehyde Slight changes in this molecule resulted in the development of different colours An examination of the formulæ of cortisone and hydrocortisone shows the presence of reactive groups similar to those of ω-OH-lævulinic aldehyde



ω-OH-lævulinic aldehyde



Part of cortisone structure

Both compounds have terminal ketol groups and a carbonyl group five or six carbons distant from the primary alcohol group

Accordingly, the diphenylamine reagent, suitably modified to improve the intensity of the reaction, was applied to various steroids (*A*) Reagent mixture 54 ml of glacial acetic acid , 6 ml of concentrated sulphuric acid , 10 ml of distilled water , 600 mgm diphenylamine (*B*) Blank mixture contains the same reagents except that diphenylamine was omitted

Depending upon the nature of the steroid, 10–50 γ of material may be determined in a micro-procedure using 1 ml of reagent, and 50–400 γ using 3 0 ml of reagent

Two equal aliquots of the steroid solution are evaporated to dryness in test-tubes To one test-tube is added reagent mixture and to the other an equal volume of blank mixture The test-tubes are then heated in a boiling water-bath for 1 hr to obtain maximum development of colour The solutions are cooled to room temperature in running tap water and are observed in a Beckman spectrophotometer, either model *B* or *D U* The colours are stable for several hours and obey Beer's law in the ranges tested, namely, 10–400 γ. The instrument is set at zero optical density with the blank mixture, and the optical density of blank mixture plus steroid is observed The instrument is now set at zero optical density with the reagent mixture, and the optical density of reagent mixture plus steroid is observed The difference between the optical density of reagent mixture plus steroid and the optical density of blank mixture plus steroid is a measure of the amount of steroid present

Table 1

Steroid (200 μgm in 3 0 ml)	Colour
Corticosterone (compound *B*)	yellowish-green
Deoxycorticosterone	faint yellow
17-OH-Corticosterone (hydrocortisone)	green
Hydrocortisone acetate	green
17,21-Dihydroxy-(3,20-dione)-$\Delta^{4,9}$-pregnadiene (anhydro *F*)	green
3α,11β,17,21-Tetrahydroxypregnane-20-one (tetrahydrohydrocortisone)	green
17-OH-11-Deoxycorticosterone (substance *S*)	green
11-Dehydrocorticosterone (compound *A*)	violet
21-Hydroxypregnane-3,11,20-trione (dihydro *A*)	faint pink
3α,21-Dihydroxypregnane-11,20-dione (tetrahydro *A*)	colourless
17-OH-11-Dehydrocorticosterone (cortisone)	violet
Cortisone-21-aldehyde	violet
Cortisone acetate	violet
3α-17,21-Trihydroxypregnane-11,20-dione (tetrahydrocortisone)	violet
Δ^6-Dehydrocortisone acetate	violet
Progesterone	faint yellow
11-Ketoprogesterone	faint yellow
11-β-OH-Progesterone	faint yellow
6β-OH-Testosterone	colourless
Δ^4-Androstene-3,17-dione	faint yellow
Δ^4-Pregnene-11β,21-diol-3,20-dione-18-al (aldosterone)	blue

The colours obtained with different steroids are shown in Table 1 Although some steroids gave no visible colour with the amounts used, all absorbed to some extent The curves in Fig 1 show the absorption spectra of the steroids after the blank values are subtracted

Those steroids that contained keto-groups at the 11 and 20 positions and hydroxyl groups at the 17 and 21 positions gave similar characteristic absorption curves with a maximum at 530 mμ These compounds gave distinct violet colours The elimination of the hydroxyl in position 17 as in compound *A* merely decreased the intensity of colour without changing the shape of the curve Increased saturation of the compound as in the 'dihydro' or 'tetrahydro' forms decreased the intensity of colour

Those steroids that contained hydroxyl groups at positions 11, 17 and 21 and a ketone at position 20 gave a green colour with a maximum absorption in the range of 630–650 mμ Again, saturation, as in 'tetrahydrohydrocortisone' or the absence of the 17-OH group, decreased the intensity of colour However, substance *S*, which has a hydroxyl in position 17 instead of in position 11, gave almost the same absorption as hydrocortisone

Fig 1 also shows the absorption spectrum of approximately 50 γ of aldosterone (kindly supplied by L H Sarett, of Merck and Co , Inc) The maximum at 640 mμ indicates the presence of a hydroxyl group at C_{11} In addition, there was a peak at 530 mμ and a negative value at about 450 mμ This compound gave a distinct blue colour which was not obtained with any of the other steroids tested

Steroids of the progesterone and testosterone type gave practically no absorption at 530 mμ or 630–650 mμ, as compared with cortisone or hydrocortisone.

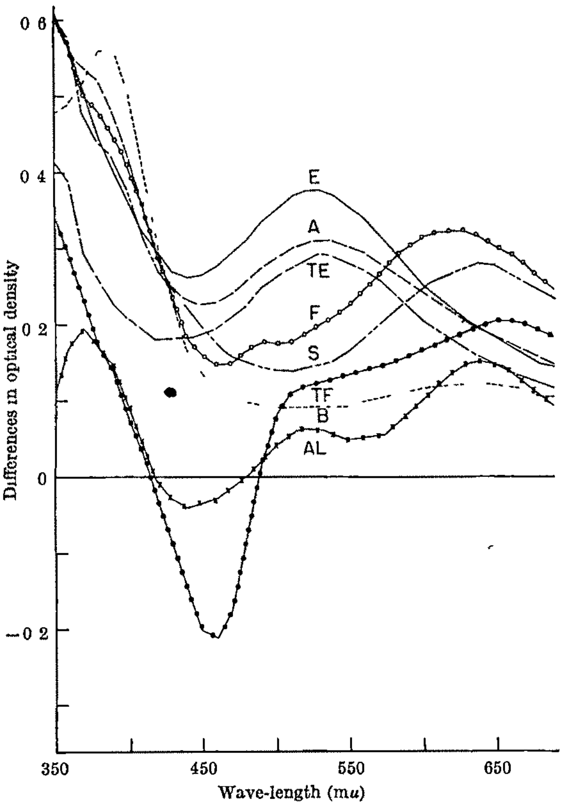


Fig 1 (*E*) Cortisone (17-OH-11-dehydrocorticosterone), (*A*), Compound *A* (11-dehydrocorticosterone), (*TE*), Tetrahydrocortisone (3α-17,21-trihydroxypregnane-11,20-dione), (*F*), Hydrocortisone (17-OH-corticosterone), (*S*), Substance *S* (17-OH-11-deoxycorticosterone), (*TF*), Tetrahydrohydrocortisone (3α,11β,17,21-tetrahydroxypregnane-20-one), (*B*), Compound *B* (corticosterone), (*AL*), Aldosterone (Δ^4-pregnene-11β,21-diol-3,20-dione-18-al)

The substitutions essential for the violet colour and the characteristic absorption spectrum of cortisone and similar steroids are (1) a hydroxyl at C_{21}, (2) keto-groups at C_{11} and C_{20} Those necessary for the development of the green colour and characteristic absorption spectrum of hydrocortisone and related steroids are (1) hydroxyl groups at C_{21} and C_{11} or C_{17} and (2) a keto-group at C_{20}

Since different absorption maxima are obtained with cortisone and hydrocortisone, it is possible to calculate the amounts of both substances by using the maximum absorption value of cortisone and the isosbestic point of the two steroids This can also be done with mixtures of any two steroids if one reacts similarly to cortisone (for example, compound *A*) and the other similarly to hydrocortisone (for example, compound *B*)

The negative value observed with 'tetrahydrohydrocortisone' (Fig. 1) appears to be characteristic of this substance and can be used for identifying it in mixtures of steroids. It is the result of a reaction between this steroid and the blank mixture. Similar reactions occur between the other steroids and the blank mixture, particularly substance *S*, compound *B* and hydrocortisone, but none of these causes any significant interference in the range 500–650 mμ.

Of the steroids listed in Table 1, it is doubtful if many will appear simultaneously in biological fluids such as blood or urine. If the mixture is not too complex, the eleven oxygenated steroids may be determined in the presence of the 11-hydroxylated steroids. This method, with an appropriate extractio is being applied to biological material and will b reported in the near future

IRWIN CLARK

Merck Institute for Therapeutic Research,
Rahway, New Jersey.
Sept 17

[1] Stacey, M, Deriaz, R E, Teece, E G, and Wiggins, L F, *Natu* 157, 740 (1946)

[2] Dische, Z, *Microchemie*, 8, 4 (1930)

Differences between Rates of Metabolism of Benzene Hexachloride in Resistant and Susceptible Houseflies

In a previous communication[1], the metabolism γ-BHC was described after injection into three strai of flies a susceptible strain (*S*), a strain resistant γ-BHC (R_1), and a strain resistant to γ-BHC a DDT (R_2)

The rate of metabolism in the susceptible stra was not comparable with that of the resistant strain since the former died rapidly, whereas the latt remained unaffected. Thus it was impossible to te whether the difference in metabolism could be cause of the difference in susceptibility

Hitherto, the method of estimation did not perm the study of the metabolism at doses low enoug to leave also strain *S* unaffected. However, th problem becomes accessible for experimentation if w assume that all isomers of BHC are metabolized b the same mechanism Then the breakdown in th strains can be studied in comparable circumstance as it is possible to estimate the α- and δ-isomer a concentrations that are not at all toxic to the flie

The flies were injected into the thorax with BH in an emulsion of peanut oil, and kept at 25° C f varying periods of time, after which the amount BHC was estimated The results are presented Fig 1 and Table 1. It is shown that there is a diffe ence in breakdown of the α- and δ-isomer betwee the susceptible and resistant strains This differen is somewhat larger in the case of the α-isomer. Th breakdown of the δ-isomer is markedly slower tha that of the α-isomer. As for technical reasons th experiments were not extended beyond 24 hr., was impossible to obtain the complete breakdow curve for this isomer

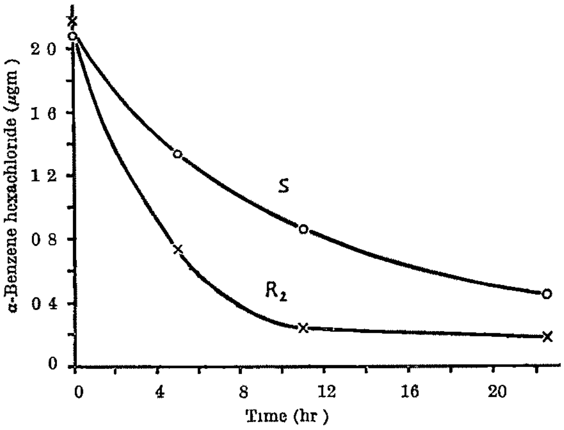


Fig 1 Amount of α-BHC per fly plotted against time after injection *S*, susceptible strain, R_2, γ-BHC and DDT-resistant strain Fifteen flies used for each estimation

Table 1 BREAKDOWN OF α- AND δ-BHC
'hirty flies used for each estimation, horizontal lines represent injections on the same day

Isomer	Amount injected per fly (μgm)	Time between injection and estimation (hr)	Breakdown (per cent) S	R_2	R_1
α	0 83	4	36	60	80
	0 93	4	36	57	57
	0 67	4	45	55	65
	2 34	5	34	—	57
	2 34	5	43	—	71
	2 34	5	40	57	—
	2 34	5	23	50	69
δ	2 34	18½	28	43	—
	2 34	18½	29	32	—
	2 34	18½	25	32	—
	2 34	18½	27	46	47
	2 34	18½	27	39	37

If our hypothesis is correct, the difference in rate of breakdown of γ-BHC between the susceptible and resistant strains has two causes (1) a difference in breakdown capacity—a possible cause of difference in susceptibility, (2) a decreasing rate of breakdown in the susceptible strain as a result of the toxic action of γ-BHC—an effect of the susceptibility.

If we assume that the metabolism results in a detoxication, it is very probable that the difference in metabolism is a cause of the difference in susceptibility, although it is as yet impossible to estimate its importance For example, it is not known how the rate of breakdown affects the concentration at the site of action. Work with more strains will perhaps be helpful in judging the significance of rate of breakdown for resistance, as it may reveal whether there exists a correlation between capacity of breakdown and level of resistance.

F J OPPENOORTH

Laboratory for Research on Biocides,
National Council for Agricultural Research T.N.O ,
Vondellaan 6, Utrecht.
Oct 4.

---

[1] Oppenoorth, F J , *Nature*, **173**, 1000 (1954)

Lysis of Human Pathogenic Bacteria by Myxobacteria

ALTHOUGH great interest has been taken in recent years in isolating antibiotics from various groups of micro-organisms, Myxobacteria have received so far very little attention Several workers have reported the lysis of bacteria (Eubacteria) by species of Myxobacteria , but no satisfactory evidence has been produced that living cells are attacked It has been shown by Singh[1], who used a large number of strains of bacteria, that certain species of Myxococcaceae undoubtedly cause lysis of both Gram-positive and Gram-negative living bacteria upon solid media Oxford and Singh[2] and Oxford[3] have shown that a strain of *Myxococcus virescens* growing on cell-free medium is able to produce two substances, an exocellular lytic (proteolytic) enzyme and an antibiotic Noren[4] has confirmed and extended this work to other species of Myxobacteria and has devised more suitable media for the production of the proteolytic enzyme and the antibiotic. The present work deals with the lysis of human pathogenic bacteria by two species of *Myxococcus*.

A strain of *Myxococcus virescens* and *M. fulvus* was tested on strains of bacteria by Singh's method[1] In all the experiments twenty-four hour old cultures of bacteria, grown at 37° C on nutrient agar slopes, were used Two streaks (about 1 in long) well separated from each other, of a bacterium to be tested, were made on a non-nutrient agar plate (1 5 per cent agar, 0 5 per cent sodium chloride , *p*H 7 0). One of the streaks was inoculated at one end with fruiting bodies of a Myxobacteria growing on living *Aerobacter* sp and the other was left as control The culture was incubated at 37° C and examined at 2–6 days.

Table 1 shows the lysis of bacterial strains by two species of Myxobacteria. Of the bacteria tested by the above method, some were readily or slowly but completely lysed, others showed partial lysis and *Mycobacterium phlei* was not lysed The dysentery, cholera and typhoid groups of organisms were attacked to varying degrees *Shigella sonnei*, *S. paradysenteriae* Flexner, *Vibrio cholerae* Ogawa 49514, *Salmonella typhosa* and *S typhosa* Vi–*I* were completely lysed by *M virescens* and only partially by *M fulvus* *V. cholerae* Rough 49515 was, however, lysed completely by the latter and only partially by the former

Table 1 LYSIS OF BACTERIAL STRAINS BY MYXOBACTERIA

Bacterial strains tested	*Myxococcus virescens*	*Myxococcus fulvus*
Staphylococcus aureus	*Pl*	*Pl*
Bacillus subtilis	*Pl*	*Pl*
Mycobacterium phlei	*Nl*	*Nl*
Shigella dysenteriae Shiga	*Pl*	*Pl*
S sonnei	*Cl*	*Pl*
S paradysenteriae Flexner	*Cl*	*Pl*
Vibrio cholerae Ogawa 49514	*Cl*	*Pl*
Vibrio cholerae Rough 49515	*Pl*	*Cl*
*Proteus X*19	*Cl*	*Cl*
Salmonella paratyphosa	*Cl*	*Cl*
Salmonella typhosa	*Cl*	*Pl*
Salmonella typhosa O-901	*Pl*	*Pl*
Salmonella typhosa H-901	*Cl*	*Cl*
Salmonella typhosa Vi–*I*	*Cl*	*Pl*

Cl = completely lysed either readily or slowly , *Pl* = partial lysis , *Nl* = not lysed

In order to find out whether the rate or the extent of lysis of the susceptible pathogenic bacteria (Table 1) by Myxobacteria could be improved, *M virescens* and *M. fulvus* were grown and subcultured a few times on the same organisms No marked difference in the lysis of the organisms was observed as compared with the results presented in Table 1.

M virescens and *M fulvus* were grown on non-nutrient agar plates with *Aerobacter* sp and *Staphylococcus aureus* at 26°, 30° and 37° C The growth of Myxobacteria was better at 30° and 37° C. than at 26° C., the effect being more marked in the case of *M. fulvus* The temperature-range of 30°–37° C was also more favourable for the production of fruiting bodies of Myxobacteria. This is in accord with the findings of Noren

Our thanks are due to Dr. B N. Singh, assistant director, Microbiology Division, of this Institute, for his interest in this work

S MATHEW
A DUDANI

Central Drug Research Institute,
Lucknow
Sept 21

---

[1] Singh, B N , *J Gen Microbiol*, **1**, 1 (1947)

[2] Oxford, A E , and Singh B N , *Nature*, **158**, 745 (1946)

[3] Oxford, A E , *J Bact*, **53**, 129 (1947)

[4] Noren, B , *Sv Bot Tidskr*, **46**, 324 (1952) , **47**, 309 and 402 (1953)

Relationship of Ovarian Hormones to the Pyogenic Effect of *Corynebacterium pyogenes*

Rowson, Lamming and Fry[1] and Lamming and Rowson[2] have reported that purulent infections rapidly become established in the uterus of the cow following introduction into the uterus of infected bull semen or cultures of *C pyogenes* during the luteal phase of the œstrous cycle, but infections introduced into the uterus of cows in œstrus fail to become established Using ovariectomized cows, the resistance and susceptibility of the bovine uterus to infection was shown to be due to the action of œstrogens and progesterone respectively The possibilities suggested to account for the variation in resistance to infection include (*a*) an increase in leucocyte activity during œstrus, (*b*) an increase in antibody activity during œstrus, (*c*) the production in the uterus during the luteal phase of an environment suitable for rapid bacterial development The present work is concerned with the effects of the uterine environment

Uteri were removed at slaughter from cows and rabbits which were in the luteal phase and from cows during the follicular phase and in anœstrus, and from rabbits injected one day previously with 10 mgm stilbœstrol and in anœstrus Using aseptic precautions, blood samples were also collected from the rabbits by heart puncture and from the cows by bleeding from the jugular vein Blood samples were also collected from cows during the luteal phase, in œstrus, and from pregnant cows

The primary aim of the work was to establish whether or not the uterus of the œstrous animal contained substances which were antibacterial in action Using aseptic precautions, the uterine mucosa of cows and rabbits was exposed and a small circle (0 5–2 0 cm diameter) of sterile filter paper was pressed against the uterine mucosa to make a swab Two swabs from each animal were placed on horse blood agar inoculated with *C pyogenes* In some cases additional swabs from cow and rabbit uteri were placed on rabbit blood agar or cow blood agar containing *C. pyogenes.* Small strips of uterine mucosa from both species were also placed in horse-, cow- or rabbit-blood agar plates with and without *C. pyogenes.* Rabbit blood was obtained by heart puncture from animals injected intramuscularly one day previously with 10 mgm. stilbœstrol, and blood samples were obtained both from pregnant cows and those in the œstrous and luteal phases. Two or three drops of plasma, or whole blood, on separate sterile filter disks were placed on horse blood agar plates with and without *C pyogenes*

Preliminary results using strips of uterine mucosa and swabs of uterine fluid showed an increased zone of hæmolysis, 3–5 mm wide, on horse blood agar plates containing *C. pyogenes* when the tissues or swabs were taken from either a cow in the follicular phase, an anœstrous cow, or a rabbit treated with stilbœstrol There was no zone of hæmolysis on horse blood agar plates containing *C pyogenes* when the uterine tissue or swab originated from either an anœstrous rabbit, cows in the luteal phase or in rabbits 3–6 days post-ovulation There were no zones of hæmolysis on horse, cow or rabbit blood agar plates without *C pyogenes* whatever the origin of the tissue or swabs

That a combination of *C pyogenes,* horse blood agar and material taken from an animal during a particular phase of reproductive activity will cause increase hæmolysis is unusual and interesting The zones of ir creased lysis occurred when tissues or blood plasm were taken from animals which, on the basis of th earlier work, would be expected to be resistant to ex perimental uterine infections It seems probable tha these zones of increased lysis are not associated wit more active growth of the test organism That th zones of increased lysis can be demonstrated usin blood plasma as well as uterine swabs and uterin tissue suggests that a general physiological effec may be present Work is continuing to decide whethe the effect is due to specific antagonistic or stimulator effects of the sex hormones, or their analogues.

George Eric Lamming
Alan Seaman
Malcolm Woodbine

School of Agriculture,
University of Nottingham
Sept 22

---

[1] Rowson, L E A, Lamming, G E, and Fry, R M, *Nature,* 17 749 (1953), *Vet Rec*, 65, 335 (1953)

[2] Lamming, G E, and Rowson, L E A, *Proc Roy Soc Med*, 4 387 (1953)

Competition among Wild Rats

Observations in the field and in large enclosure have shown that feral rats (*Rattus norvegicus* Berkenhout), unlike albinos of this species, display, in a highly developed form, both territorial and othe types of competitive behaviour[1–3] Interspecifi competition, between *R. norvegicus* and *R rattus* L has also been directly observed[2] These studies have however, thrown little light on the exact circum stances which evoke competition, or on the precis nature of the behaviour involved

Colonies of both species of rats have been main tained in cages of about 1 cu m, with attached nes boxes Cinematograph films have been taken of som colonies in a cage with a glass front. The rats wer marked with a depilatory In these conditions, group of adult males of both species, trapped in Glasgo or bred from rats so trapped, have lived for up t twenty-two weeks without mortality, and usuall without injury Generally, several individuals slep together in a nest box, without distinction of species Thus competitive behaviour is not necessarily evoke by the presence of another male, or by a member o a closely related species. In these experiments al the males were introduced, at the same time, into ar unfamiliar cage However, as described also else where[2], *R norvegicus* males newly introduced intc an established colony were often persecuted b members of their own species some died within a few days This type of competitive behaviour is evidently the result of the establishment of a territory Females of both species will also live together without conflict Non-parturient females differ from males however, in not showing territorial behaviour

R norvegicus males, put in cages together wit females of the same species, fight vigorously In the first of such experiments only one (the heaviest) out of six males survived after eleven weeks Contro males, litter mates of the experimental animals, kept singly in small cages each with one female, showed no mortality, these pairs have produced many viable litters Females do not fight as males do, and they nearly always survive the experiments without injury They readily become pregnant during the experiments, but there is a high mortality among the nestlings. Thus competition in this species is markedly different in the two sexes, and it can be evoked among males by the presence of females.

Fighting does not involve serious wounding to either rat involved, though vigorous, it is formal rather than, in itself, lethal. Injuries may include superficial damage to tail or ears, or occasionally to limbs, sometimes the skin is torn in the neck region. Deaths appear to be due to exhaustion rather than to wounding, and sometimes occur without detectable external damage. In the male–female colonies, the weights of some males rose during the experiments, but the weights of most fell. All the control males in small cages increased in weight. The experimental males which grew most tended to be those which were initially heavier than the rest, some of these successful males grew more than any of the controls.

Adrenal glands of males used in these experiments were removed, weighed and examined histologically. The adrenal cortex of subordinate rats involved in severe fighting over short periods, for example, two days, showed marked depletion of sudanophilic material, such as is found also in other forms of 'stress'[4]. On the other hand, subordinate males examined after some weeks of exposure to moderate competition showed little or no depletion, in these, however, there was evidence of hypertrophy of the adrenal cortex, since the relative weights of their adrenals were higher than those of the controls. Dominant males, which had fought just as much, or more than, the depleted subordinate males, showed no depletion. This suggests that the exhaustion of subordinate males is not merely a consequence of violent exercise, but also involves more complex nervous and endocrine changes.

The method described here allows detailed observation and filming of the social behaviour of marked rats, and makes it possible to relate the behaviour seen to physiological changes revealed at autopsy. The results indicate that competition among wild rats is evoked by a number of quite specific situations, which can be analysed by experiment in the laboratory. Full accounts of this work will be published elsewhere.

S. A. Barnett

Department of Zoology,
University, Glasgow.
Sept. 30.

[1] Barnett, S. A., *J. Hyg., Camb.*, 49, 22 (1951).

[2] Barnett, S. A., and Spencer, M. M., *Behaviour*, 3, 229 (1951).

[3] Calhoun, J. B., *Science*, 109, 333 (1949).

[4] Selye, H., "The Physiology and Pathology of Exposure to Stress" (Montreal, 1950).

Black Grub Infection in *Catla catla*

More than 150 fingerlings of the fish *Catla catla* (Ham. Buch.) collected in July 1953 from freshwater sources in Samalkot, East Godavari District, Madras, were heavily infested with black grub cysts embedded under the skin and distributed all over the body. In one specimen, more than three hundred cysts were encountered. Cysts were excised and ruptured under a coverslip to release the larva, with or without its own envelope, and its organization studied by clearing it with phenol.

The black colour is due to the dendritic pigmentation on the fibrous, elliptical host-cyst, inside which floats the colourless larva invested by a gelatinous parasite-cyst. The parasite proved to be a metacercaria of a strigeid trematode.

Its structural details (Fig. 1) are briefly as follows: body typically bi-lobed, with almost equal halves, the fore-body filled with glands and less transparent than the hind-body, oral sucker broader than long, pharynx elongated, œsophagus narrow and slender, and intestinal cæca extending far into the hind-body, accessory suckers laterally situated, prominent and larger than the oral, acetabulum smaller than the oral sucker, placed in the region of the bifurcation of the œsophagus, hold-fast organ immediately behind it, nearly as large as the accessory suckers, circular or oval, with a longitudinal cavity, genital rudiments confined to the hind-body and recognizable as an oval, slightly lobed ovary to the outside of the cæcum, three lobes of testes, of which two are elongated and overlie the cæca and the third is oval and apposed to one of them, two branched excretory ducts on the inside aspect of the cæca unite posteriorly to open by a common terminal pore.

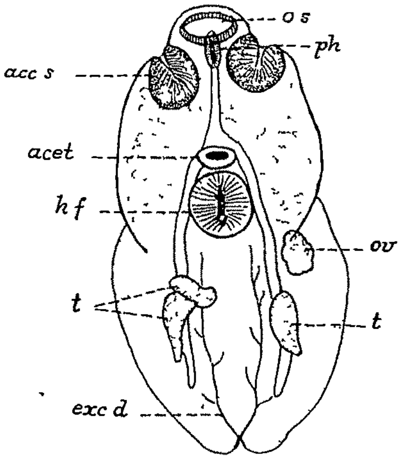


Fig. 1. Strigeid metacercaria from *Catla catla*. acc s, accessory sucker, acet, acetabulum, exc d, excretory duct, h f, hold-fast organ, ov, ovary, o s, oral sucker, ph, pharynx, t, testis

Among the several larval genera to which strigeid metacercariæ are attributed, *Diplostomulum* is one which possesses distinct accessory suckers, but it lacks a cyst-wall and inhabits mostly the eyes of fishes, though it may occur in other situations less often[1–3]. Black grub is caused by the genus *Neascus*[2,4], around which a host-cyst is developed. The metacercaria now described conforms to the morphological pattern of a *Neascus* in every aspect except for the possession of accessory suckers, and recalls the characters of the adult genus *Diplostomum* to a high degree.

To determine the identity of the adult worm, experimental infection of two ducks was attempted. Each bird was fed with live *Catla catla* having a heavy burden of metacercariæ, but no evidence of successful infection was obtained. Possibly other piscivorous birds like the egret and the snipe may prove susceptible.

It has been customary to recognize larval genera among Strigeids, and two of them—*Diplostomulum* and *Neascus*—have been referred to here as relevant, and it has been shown that the black grub of *Catla* does not correspond with either on all counts. But the similarity in structure between this one and the adult genus *Diplostomum* is emphasized to indicate the probable identity of the form.

This investigation is in progress as an item in the study of fish parasites, and a detailed account may be awaited We are grateful to Mr M Devidas Menon, assistant director of fisheries, Madras, for providing facilities, to Dr G Dubois, Neuchâtel, for valuable information, and to the Director of Industries and Commerce, and the Director of Animal Husbandry, Madras, for permission to publish these observations

FLORENCE G. ABRAHAM
M. ANANTARAMAN

Freshwater Fisheries Research Station,
Madras 10,
and
Veterinary College, Madras 7. Sept. 2.

---

[1] Dawes, Ben, "Trematoda" (Camb Univ Press, 1946) Haderlie, E C, *Univ Calif Pub Zool*, 57 (5), 303 (1953) Hughes, R C, *Trans Amer Micro Soc*, 46, 248 (1927) Hunter, G W, and Hunter, W S, *J Parasit*, 20, 328 (1934)

[2] Hyman, L H, "The Invertebrates", 2 (1951) Kaw, B L, *Ind J Helm*, 2 (2), 67 (1950)

[3] Lal, M B, *Nature*, 171, 130 (1953)

[4] Chandler, A C, *Amer Midl Nat*, 45 (3), 711 (1951)

Molecular Orientation in the Wings of a Termite

THE orientation of complex molecules in certain tissues is well known[1] I have recently observed that, although the main structure of the wing of a termite (*Macrotermes* sp) is isotropic, the two principal anterior veins (costal and sub-costal), running approximately parallel to the leading edge and to each other, show very marked anisotropy with the extinction direction parallel to the vein axis These brown veins appear to contain both chitin and sclerotin

X-ray photographs taken about the vein axis using copper K_α radiation lead to the idealized fibre diffraction patterns shown in Fig 1 (*a* and *b*) In both cases the rings are barely visible except very near the sickles The equatorial spacing of the untreated vein, Fig 1*a*, is 4 63 A, the meridional one is 3 48 A, with the sickles corresponding to not more than 7° disorientation These spacings could correspond either to fully extended β-keratin-type chains running in the direction of the vein axis (± 7°) with randomly orientated cross-linkages, or to orientated chitin molecules It seems likely that both these sources are contributing to the total diffraction pattern

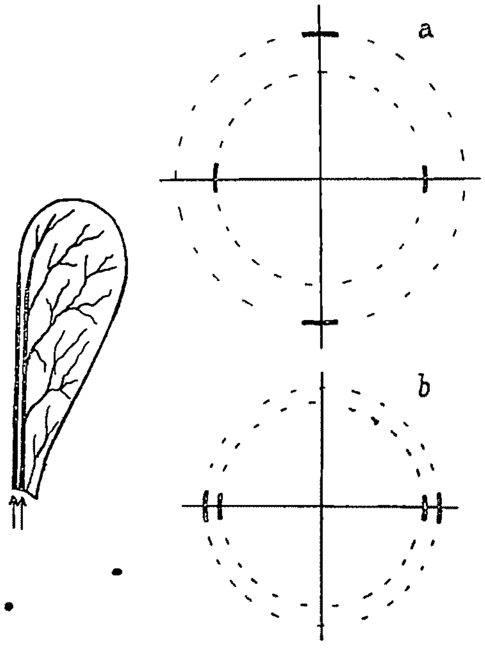


Fig 1 (*a*) Original fibres, (*b*) treated fibre Left principal veins on wing, indicated by arrows orientation corresponds to that of (*a*) and (*b*)

The veins may be cleaned and bleached by boiling them in concentrated potassium hydroxide for about twenty minutes. If the bleached vein is washed with ethanol and water and air-dried, the diffraction pattern of Fig 1*b* can be obtained This shows that the meridional spacing is no longer present, but that another equatorial spacing has appeared at 4 13 A, in addition to the former spacing at 4 63 A Hence the principal chain must be largely disintegrated by boiling with potassium hydroxide

RALPH HULME

University College, Achimota,
Gold Coast Sept 14

---

[1] Richards, A G, "The Integument of Arthropods", 14ff and 59ff (Minnesota, 1951)

Photoelectric Cell Observations of Insects in Flight

RECENT work in this Laboratory involved the exposure of a red-sensitive cæsium photoelectric cell to direct sunlight, the cell output being fed to a high-gain audio amplifier and a loud-speaker instead of the more usual d c. amplifier-galvanometer chain It was observed that occasional brief (< 0 25 sec) random 'bursts' of sound occurred, of apparent frequency between 100 c /s and 500 c /s. The number of 'bursts' in a given time varied considerably during the day, but appeared to rise to a peak in the late afternoon No moving object which might immediately explain the phenomenon was visible to the naked eye, and the sound produced was quite different from the continuous 'rumble' produced when tenuous cloud drifted across the sun's disk

The recording system was amended to use two photoelectric cells close together and feeding separate amplifiers. Observation of a number of 'bursts' showed that in many cases a burst recorded in one channel was followed after a discrete time-delay by a similar burst in the other channel This suggested moving objects as the cause, and from the geometry of the system and the duration of a burst, established their speed as of the order of 5–10 m p h and their range as relatively close.

Several of the bursts were recorded on magnetic tape and later played back, displayed on an oscilloscope, and their wave-forms photographed (p 129) Fig 1,*a* shows a typical burst of duration about 0 15–0 2 sec , and Fig. 1,*b* shows the same occurrence displayed on a faster sweep (150 m.sec.)

It is almost certain that these bursts of sound are caused by insects flying across the optical path between the sun's disk and the photoelectric cell, the generated frequency being due probably to the oscillation of the insect's wings, and the insects themselves being beyond the range of the unaided human eye or ear

Several different types of captive insect, for example, bee, common housefly, have been exposed in a transparent container to the photoelectric cell and their wave-forms obtained. Fig 1,*c* shows the wave-form produced by a bee fluttering its wings, photographed at approximately the same speed of sweep as was Fig 1,*b*. It will be seen that there is a close

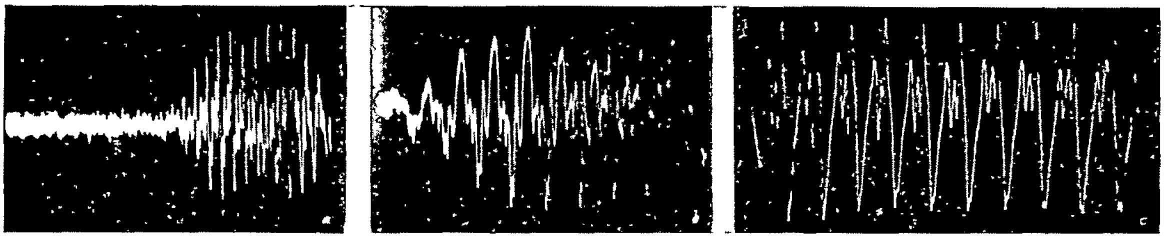


Fig 1

similarity. The fundamental period here is about 80 c /s , but the very high harmonic content makes the sound as recorded appear aurally much higher in pitch.

This phenomenon is reported here because it seems possible it might be turned to account by workers interested in the flight habits of insects, and particularly in variations in insect density during daylight hours

I R Richards
Dominion Physical Laboratory
(Department of Scientific and Industrial Research),
Wellington, New Zealand
Nov. 3

Optical Rotation and Polypeptide Chain Configuration in Proteins

Observations on the optical rotation of collagen and gelatin[1], together with consideration of polarimetric data reported in the literature for these and other proteins[2-6], have suggested the following simple hypotheses relating optical rotativity and polypeptide chain configuration

(1) Randomized chain configurations, provided by conditions which cause 'denaturation', exhibit rotations believed to correspond to the sums of effectively independent contributions of the L-amino-acid residues present. Values of $[\alpha]_D$ in the neighbourhood of − 100° characterize such states. For example, when native globular proteins are denatured by urea or similar reagents, the rotation invariably changes from an initially low negative value to about the range − 80° to − 120° [2-4]. Hot gelatin sols from various sources also show similar rotations[1,5,6]. Deviations within or near this range probably depend on variations (*a*) in completeness of denaturation, (*b*) in the amino-acid composition of the proteins involved, or (*c*) in minor aspects of the predominantly aqueous environments used for the measurements.

(2) The rotation in the native state appears to be the result of effects of specific main-chain configuration superimposed on or otherwise changing the optical rotation from that of independent, asymmetric α-carbon atoms alone. The resultant total rotation of the native protein may be appreciably greater or less than is obtained after denaturation Examples of the two possibilities are considered separately

(*a*) It is suggested that the very high negative rotations of native collagen solutions may result in large part from a helical configuration characteristic of the polypeptide main chains A citrate-soluble fraction of ichthycol (from the tunic of carp swim bladders) yielded[1] a specific rotation of − 350° under conditions which Gallop[7] has shown disperse the collagen as protofibrillar particles with mass per unit of (contour) length similar to that in normal condensed states (fibrils of connective tissues in general). Wide-angle X-ray diffraction studies have indicated that in these solid states there is helical structure along at least parts of the polypeptide chains[8]. Since the particulate cross-sections are not greatly altered during dispersion, it is reasonable to conclude that at least some of the helical configuration is retained in solution

As suggested by Robinson[5], a recovery of the native backbone configuration by gelatin upon cooling accounts for the high rotation of gelatin in gels and in films formed by evaporation in the cold. The latter also yield the characteristic infra-red absorption and wide-angle X-ray diagram of collagen Robinson described these phenomena in terms of a return of the specific 'collagen fold', which is here further described as helical. In comparable solution environments, however, the recovery seems to be incomplete, since gelatin does not fully regain the rotation of collagen[1]

(*b*) The specific rotations of native globular proteins are relatively low (− 30 to − 60°)[2,9]. Either (i) the main chain configuration is such as to oppose or to reduce the contributions of the α-carbon atoms weakly, or (ii) there are large cancelling effects resulting from enantiomorphic chain configurations The latter alternative becomes more likely if modern concepts of the importance of helical polypeptide chain configurations prevail, and if the case of collagen is taken as indicating that polypeptide helices should exhibit strong rotation. A complete cancellation of backbone effects need not result from a mixture of equal numbers of left- and right-handed helices composed of L-amino-acids, since one cannot assume that the contribution to rotation from the backbone dissymmetry is strictly additive with that due to the asymmetric α-carbon atoms.

(3) Since the pyrrolidine residues have special significance for main-chain structure, they may also be influential in determining optical rotation Helical configurations (including the α-helix) have no preferred sense of twist so long as imino-residues need not be incorporated frequently along the coil In fact, the occasional presence of such residues provides a means of turning corners or of producing a reversal of sense of twist[10] Thus, one might expect optically opposing chain configurations to occur in native globular proteins On the other hand, the uniquely high proportion of imino-residues in collagen provides a possible stereochemical reason for helices of one sense of twist, hence for large optical rotation, in that protein

An alternative explanation of the uniquely large rotation in collagen and cold gelatin, which seems less likely, is that the imino-residues may have unusually large rotations because of strains in the pyrrole ring, about the α-carbon, introduced when chains containing the pyrrolidines are impressed into the collagen configuration. In this case a specific rotation of − 350° for the protein would correspond to an estimated rotation of about − 1,200° for these residues

Finally, we may note that the comparisons made above have been based on rotations in the visible spectrum, in particular the sodium-*D* line, and that small differences in the rotatory dispersion bands, which are located in the ultra-violet for proteins, should not invalidate these generalizations The possible significance of the exact position of these absorption bands as an additional criterion for backbone configuration has recently been pointed out by Linderstrøm-Lang and Schellman[11]

This work was supported in part by a grant-in-aid, for the study of connective tissue structure, under the supervision of Prof. Richard S Bear, from the American Cancer Society upon recommendation of the Committee on Growth, National Research Council I thank Prof Bear for advice and encouragement, as well as Dr Alfred Gierer for helpful discussions This report is based on part of a Ph D thesis submitted to the Massachusetts Institute of Technology, June 1954

CAROLYN COHEN*

Department of Biology,
Massachusetts Institute of Technology,
Cambridge 39, Mass , U S A
Nov 3

---

* Present address Wheatstone Physics Laboratory, King's College, London, W C 2

[1] Cohen, C , *J Biophys and Biochem Cytology* (in the press)

[2] Jirgensons, B , *Arch Biochem and Biophys* , 39, 261 (1952) , 41, 333 (1952)

[3] Kauzmann, W , *et al* , *J Amer Chem Soc* , 75, 5139, 5152, 5154, 5157, 5167 (1953)

[4] Yang, J T , and Foster, J F , *J Amer Chem Soc* , 76, 1588 (1954)

[5] Robinson, C R , "Nature and Structure of Collagen", 96 (edited by J T Randall, Academic Press, N Y , 1953)

[6] Smith, C R , *J Amer Chem Soc* , 41, 135 (1919)

[7] Gallop, P M , *Arch Biochem and Biophys* (in the press)

[8] Cohen, C , and Bear, R S , *J Amer Chem Soc* , 75, 2783 (1953)

[9] Doty, P , and Geiduschek, E P , "The Proteins", 1, part A, 410 (edit by H Neurath and K Bailey, Academic Press, N Y , 1953)

[10] Pauling, L , Pasadena Conference on the Structure of Proteins, September 1953 See Edsall, J T , *Science*, 119, 302 (1954)

[11] Linderstrøm-Lang, K , and Schellman, J A , *Biochem et Biophys Acta*, 15, 156 (1954)

Gamma-Rays from Proton Bombardment of Sodium

THE yield of the (p,γ) capture process in sodium-23 has been studied for proton energies ranging between 0 5 and 1 0 MeV

Thin vacuum-evaporated sodium iodide and thick sodium sulphate targets were bombarded with protons from the van de Graaff generator The magnetic field of the analysing magnet was measured by means of a proton resonance fluxmeter As a detector for the γ-rays a sodium iodide (tantalum) crystal was used Calibration was achieved by means of the 873 5 ± 0 8 keV. resonance in the $^{19}F(p,\alpha\gamma)^{16}O$ reaction[1].

Table 1

Curran (ref *a*)	Tangen (ref *b*)	Burling (ref *c*)	Freeman (ref *d*)	Turner (ref *e*)	Our results	Rel intensities
525	510±5	515			512 0±2	1
590		598	590	594 5 ±1 5	592 3±2	3
690		676*			677 0±2	10
755		735	740		743 0±2	4 5
875		867			873 7±2	9

a, Curran, S C , *Proc Roy Soc* , A, 172, 72 (1939)
b, Tangen, R , *Kgl Norske Videnskab Selskabs Skrifter* (1946)
c, Burling, R L , *Phys Rev* , 60, 341 (1941)
d, Freeman, J M , *Nature*, 162, 696 (1948)
e Turner, O H , *Aust J Phys* , 6, 380 (1953)
* Misprinted as 576 in Burling's paper

In Table 1 the resonances are listed and compared with the results of other authors[2]. The resonance near 874 keV is in some papers supposed to be due to fluorine contamination It has been shown recently[3], however, that there is also a sodium resonance close to that energy The fluorine contamination in our targets was found to be less than one part in 500,000

K NYBO
T GROTDAL

Physics Department,
University of Bergen
Nov 2

---

[1] Morrish, A H , *Phys Rev* , 76, 1651 (1944)

[2] Endt, P M , and Kluyver, J C , *Rev Mod Phys* , 26, 95 (1954)

[3] Teener, J W , *et al* , *Phys Rev* 93, 1035 (1954)

Paramagnetic Resonance in Copper Phthalocyanine

PARAMAGNETIC resonance measurements on copper phthalocyanine are of considerable interest for two reasons First, the central structure of the phthalocyanine molecule is similar to that of hæmoglobin and chlorophyll[1], and hence any detailed information that can be derived on the electronic binding will be of great biophysical importance Secondly, the copper atom is surrounded by four nitrogen atoms, and not water molecules, as in nearly all the copper salts previously studied by paramagnetic resonance It was therefore expected that the observed *g* factors and hyperfine splittings might be somewhat different from the usual values[2], and this has been confirmed, the hyperfine splitting along the field axis being nearly twice as great as the maximum values previously reported

Initial measurements on concentrated crystals have been briefly reported before[3] , but it has now proved possible to observe signals from diluted crystals, and thus resolve the hyperfine structure, and study its angular variation. It can be seen from the results summarized below that a considerable amount of data is now available for calculations on the copper–nitrogen bonding. Since the crystal size is limited to about 0 5 mm [3], all the measurements have been made at either 1 25 cm. or 8 mm wavelengths, and temperatures down to 20° K have been employed to increase the sensitivity The hyperfine splittings and *g* values were all measured by means of a proton resonance magnetic field meter, and good signals were obtained from coils of 2 mm diameter, which enabled simultaneous measurement of the proton and electron resonance in all cases

Detailed X-ray analysis is available for the metal phthalocyanines[4], and the orientation of the planar molecules with respect to the crystalline axes is known accurately It is therefore possible to correlate all the paramagnetic resonance measurements with the actual directions of the copper–nitrogen bonds The central structure of the copper phthalocyanine consists of a square, formed by four nitrogen atoms, with the copper atom at the centre, coplanar with the rest of the molecule There are two molecules per unit cell, and hence two spectra are usually observed The magnetic field was rotated around the crystal, in the '*ab*', '*bc*' and '*ca*' planes, and then in, and perpendicular to, the plane of the molecules

The diluted crystals show four hyperfine components, due to the $I = \frac{3}{2}$ of ^{63}Cu and ^{65}Cu With present sensitivity the line-width cannot be reduced much below 50 gauss, and so far no fine structure, due to any covalent linkage with the nitrogen atoms, has been observed The maximum splitting between successive hyperfine components is 210 ± 10 gauss, and the maximum g value is 2 165 ± 0 004, both occurring along the axis through the copper atom normal to the plane of the four nitrogens In the plane perpendicular to this axis, that is, the plane of the molecule, the g-value remains isotropic at 2 045 ± 0 003 The hyperfine splitting in this plane collapses to an ill-resolved pattern, as is usual in copper salts, having an approximate value of B = 30 ± 10 gauss. However, there does seem to be a 180° variation of this splitting for rotation in the plane of the molecule The difference is small but appears to be outside the experimental error, and is being studied more closely, as it may give information which differentiates the individual copper–nitrogen bonds

The same g values and hyperfine splittings are obtained at both 1 25 cm and 8 mm wave-lengths, and also over a temperature-range of 20°–290° K They can be summarized in terms of the normal spin Hamiltonian coefficients as

$$\begin{array}{llll} g_{\shortparallel} = 2\ 165 \pm 0\ 004, & g_{\perp} = 2\ 045 \pm 0\ 003 \\ A = 0\ 0208 \pm 0\ 001\ \text{cm}^{-1}, & B = 0\ 0031 \pm 0\ 001\ \text{cm}^{-1} \end{array}$$

The quadrupole interaction coefficient, Q, has not been calculated yet, as more sensitive apparatus is being constructed to allow greater dilution and better resolution It is then hoped to carry out a detailed study of the hyperfine splitting in the molecular plane, and also search for any interaction of the electrons with the nitrogen nuclei.

This work forms part of a general programme for studying phthalocyanine, hæmoglobin and chlorophyll derivatives by paramagnetic resonance We would like to thank the Royal Society for a grant towards the cost of the apparatus, Imperial Chemical Industries, Ltd, and Dr C E Dent for supplying phthalocyanines, Dr Stevens for much helpful discussion, and the Department of Scientific and Industrial Research for a maintenance grant (J E B)

J E Bennett
D J E Ingram

The University,
Southampton
Dec 13

---

[1] Linstead, R P, Lowe, A R, Dent, C E, and Byrne, C T, *J Chem Soc*, ii, 1016 (1934)

[2] Bleaney, B, Bowers, K D, and Ingram, D J E, *Proc Phys Soc*, A, 64, 758 (1951)

[3] Ingram D J E, and Bennett, J E, *J Chem Phys*, 22, 1136 (1954)

[4] Robertson, J M, *J Chem Soc*, i, 615 (1935)

Fixation in Electron Microscopy

Many specimens for electron microscopical examination are in the form of suspensions in salt solution These are commonly dried on the specimen support film, and the unwanted salt crystals are removed by washing, with resultant uncertainties due to loss of material during the process, which losses may well be selective The salts are sometimes first removed from the suspensions by dialysis, but this may lead to changes in aggregation, or to loss by precipitation before the material can be finally laid down

These difficulties have been largely overcome here by working on a micro scale and using the mounting film itself as the dialysis membrane The film is floated off a glass support on to a water surface in the usual way, and a single drop (or sometimes a spray of micro-drops) is placed on top of the film. The salts diffuse through the film very rapidly as it is usually only 300 A thick, and the specimen is then mounted in the normal manner

Further, it is often desirable to fix such specimens without change of electrolyte balance in the process This is now readily achieved by placing drops of the suspension on a mounting film floating on a bath of the suspending medium, which contains the fixative in addition to the normal concentration of salts. Fixation proceeds gradually by diffusion of the agent through the film and the bottom of the drops, or in the vapour phase through the top of the drops, without change in electrolyte balance Removal of unused fixative and unwanted salts is accomplished by transferring the film to a water surface as before The concentration of the fixative gradually rises in the drops from zero to that of the main bath Such progressive fixation has been shown to be most desirable, and the dangers inherent in adding concentrated fixative to the suspension itself are avoided

Similarly, other micro-chemical modifications of the specimen material may be carried out without fear of selective loss by precipitation and consequent rejection prior to normal mounting procedures, since the insoluble contents of the original drops necessarily remain on the mounting film

The method has been used to advantage over the past two years in studies of tumour and normal tissue extracts, isolated cell components (lipid fraction, mitochondria, microsomes), bacteriophage behaviour at various pH-levels (precisely controlled by working with standard buffer solutions) and the organisms of pleuro-pneumonia and related materials

F W Cuckow

Chester Beatty Research Institute,
Royal Cancer Hospital,
Fulham Road,
London, S W 3
Oct 29

Allotropes of Tungsten

The element tungsten has been observed to exist in two structural forms the commonly encountered modification, which is body-centred cubic with a = 3 16 A, and another which has a more complex cubic structure with 21 atoms per unit cell and a = 5 04 A These forms have been designated α and β respectively by Hartmann, Ebert and Bretschneider[1], who first reported the existence of the β-form, and this nomenclature is commonly accepted, although Neuberger[2] reverses the designations

Hartmann and others have shown that the β-form is stable below c 650° C, above which temperature it is irreversibly converted to α-tungsten, the transition being relatively sluggish No reports have yet been published that α-tungsten can be reconverted to β-tungsten by purely physical processes, so that it has only been obtained hitherto by winning the element at temperatures below the transition temperature Metallic tungsten prepared at these temperatures is, however, only obtained in the β-form by the decomposition of certain of its compounds

In this laboratory, tungsten has been prepared by several different methods and the product has been examined by X-ray diffraction The results obtained are tabulated below, together with others taken from the literature

Method of preparation	Temperature (° C)	β-Tungsten present
Hydrogen reduction of β-oxide ($W_{20}O_{58}$)	465–720	+
Hydrogen reduction of γ-oxide ($W_{18}O_{49}$)	470–660	+
Hydrogen reduction of δ-oxide (WO_2)	550–590	—
Hydrogen reduction of WCl_6 vapour	c 430	—
Hydrogen reduction of $WOCl_4$ vapour	c 430	—
Electrolysis of fused melts containing tungstates or WO_3	600	+
Electrolysis of fused melts free from oxides	450–550	—
By an oxidation reduction cycle*	600	+
	700	—
Electrolysis of phosphate containing WO_3 (ref 1)	600–750	+
Electrolysis of tungstates (ref 3)	500	+
Hydrogen reduction of WO_3 (ref 4)	up to 800	+
Films of tungsten developed on the envelopes of lamps (ref 4)	—	+
Sputtered films (ref 5)	—	+
On tungsten electrodes of spark gap (ref 5)	—	+

* The oxidation-reduction cycle involves the transfer of metal from a tungsten filament, held at c 2,000° C in wet hydrogen, on to a nearby surface which was maintained at the temperature given in the table

It should be noted that β-tungsten may be detected in metal formed at temperatures above the transition temperature, and this fact confirms the slowness of the β–α conversion

We conclude that β-tungsten can only be formed by chemical processes, and then only when certain oxides are present or likely to be formed in the system Our findings, and evidence from other work in this laboratory, appear to offer additional support for the proposal by Hagg and Schonberg[6] that the β-form is, in reality, an oxide of tungsten Work is continuing on this subject, and we hope to publish a more complete report later

We wish to thank Mr M G Harwood, who was responsible for the X-ray diffraction examination of samples, and Mr J A M van Moll and the directors of Philips Electrical, Ltd , for permission to publish these results

M G Charlton
G L Davis

Material Research Laboratory,
Philips Electrical, Ltd.,
New Road,
Mitcham Junction, Surrey
Oct 4

---

[1] Hartmann, H , Ebert F , and Bretschneider, A , *Z anorg Chem* , **198**, 116 (1931)

[2] Neuberger, M C , *Z Krist* , **85**, 232 (1933)

[3] Burgers, W G , and van Liempt, J A M , *Rev Trav Chim* , **50**, 1050 (1931)

[4] Rooksby, H P , *Nature*, **154**, 337 (1944)

[5] Petch N J , *Nature*, **154**, 337 (1944)

[6] Hägg, G , and Schonberg, N , *Acta Cryst* , **7**, 351 (1954)

Fine Structure of Solar Radio Transients

The impending rise of solar activity makes it appropriate to discuss some observations which have been only reported upon orally[1] and mentioned in the popular press[2]. At 480, 160 and 51 Mc /s a study was made of progressive disturbances in the solar atmosphere[3] using high-speed recordings with fast instruments Solar bursts were found to be composed of a great number of small transients or discrete pips Each pip had a steep but not impulsiv rise, an approximately half-sinusoidal top, at first rapid decay and a quasi-logarithmic tail Its duration was taken as the elapsed time, to the neares tenth of a second, between points at 0 707 of maximum amplitude Plots were made of duration versu amplitude which turned out to be scatter diagrams Ninety per cent of the durations fell between two thirds and three halves of the median, and wer independent of amplitude throughout a range o more than one to a hundred These limits represen the smallest pips observed on a quiet day and th largest separate pips during an outburst Th median durations were respectively 0 7, 2 and 6 sec Thus the duration of a pip in seconds is approximately equal to its observed wave-length in metres, o $T = \lambda$ Obviously the many overlapping pips in solar burst are the result of many discrete source acting independently Periods of high-variabl background are merely a great number of pips o nearly the same amplitude and random timing

No correlation could be found between any o the fine structure at 160 and 205 Mc /s , so the band width of a pip must be much narrower At 15 and 160 Mc /s large pips on one trace could alway be found in counterpart on the other trace Abou one in a hundred of the large pips had amplitude equal within 2 per cent Approximately one-fift had amplitudes equal within 10 per cent As weake pips were considered, the correlation became poorer Small wiggles were entirely random and probabl represent the spectral tails of pips at far-remove frequencies Obviously the spectral width of a pi is only a few per cent of its mean frequency. Visua inspection indicated that the pips of medium amplitude were often of more nearly equal amplitude tha the very strong pips Thus an inverse relationshi may exist between spectral-width and amplitude. Th frequency of occurrence of the pips was greatest a 160 Mc /s , but the mean amplitude increased in direct way with wave-length

A few suitable recordings were made by Cornel on 1,420 Mc /s which showed some small pips wit durations of a couple of tenths of a second Publishe data[4] at 19 Mc./s show pips about a quarter of minute long. During the greatest sunspots of 194 and 1947, surges with durations from a half to on minute were observed[5] down to 6 7 Mc /s. All thes observations provide evidence that the relatio $T = \lambda$ holds approximately over a range of severa hundred to one in wave-length Some of the low frequency data[6] confirm that the spectral width i small, such as November 18, 1948, 0135 G M T peak noise 8,330 kc /s., limited to 8,270–8,400 kc /s.

Apparently, there is a fundamental relatio between the mode of generation of these transients the location of the source in the solar atmospher and the duration of a pip These observations wer made by me during 1948–50 while associated with th National Bureau of Standards

Grote Reber

Wailuku, Maui,
Hawaii
Oct 12

---

[1] Reber, Grote, A A S Meeting, Tucson, Arizona, Dec 28, 1949

[2] Henry, Thomas R , *Washington Star* (Feb 27, 1950)

[3] Reber, Grote, *Science*, 312 (1951)

[4] Payne-Scott, Ruby, *Aust J Sci Res* , A, 214 (1949)

[5] *N Z J Sci Tech* , 140 (1947)

[6] Private communication from New Zealand Post Office Departmen (Feb 20, 1952)

Preparation of Dry Nitrocellulose Membranes and Nitrocellulose Particles.

'GRADOCOL' membranes of pore diameter less than 00 mμ change their characteristics when normally llowed to dry in air These changes, which are reversible, include a decrease in thickness and pore iameter when the membranes are re-equilibrated in ater (Table 1) Membranes dried in this way and tored in the dark in contact with one another in a eighing bottle 2 in diam × 3 in height tend to oalesce and decompose after long periods of storage Membranes of low porosity are not easily re-wetted ith water after being dry for several days 'Gradocol' embranes may be dried by the method outlined elow and stored for long periods without impairent of their characteristics

Table 1

Before treatment					After treatment				
Thickness (mm)	*RFW*	*SWC*	*APD* (mμ)	Bursting pressure (lb /sq in 8 mm)	Thickness (mm)	*RFW*	*SWC*	*APD* (mμ)	Bursting pressure (lb /sq in 8 mm)
0 147	0 353	0 863	150	16	0 133	0 208	0 800	119	19
0 190	1 63	0 857	323	13	0 180	0 829	0 821	235	17

Table 2

Before treatment					After treatment				
Thickness (mm)	*RFW*	*SWC*	*APD* (mμ)	Bursting pressure (lb /sq in 8 mm)	Thickness (mm)	*RFW*	*SWC*	*APD* (mμ)	Bursting pressure (lb /sq in 8 mm)
0 038	0 0000347	0 296	2 5	100	0 038	0 0000416	0 300	2 8	99
0 054	0 0000797	0 470	9 6	69	0 053	0 000718	0 460	9 2	72
0 109	0 0148	0 819	31	44	0 110	0 0147	0 803	31	42
0 168	0 0891	0 869	75	34	0 167	0 0905	0 859	76	33
0 232	0 391	0 874	156	17 5	0 236	0 401	0 865	159	18
0 143	1 77	0 808	346	13 5	0 143	1 81	0 820	347	14
0 154	3 84	0 828	504	23*	0 158	3 80	0 818	501	23*
0 138	10 0	0 822	815	16*	0 137	9 97	0 824	813	16*
0 149	23 9	0 830	1,253	11*	0 151	23 0	0 810	1,250	11 5*
0 119	42 9	0 791	1,723	12*	0 121	41 7	0 782	1,700	12*
0 139	59 9	0 812	2,008	—	0 140	58 9	0 811	1,991	—

* Values for the test when disk with hole 4 mm diam was used The data shown in columns 5 and 10 indicate the relative strengths f the membranes The membrane was supported on a brass disk of thickness 2 mm having a central circular hole of diameter 4 mm or 8 mm he disk with membrane surmounted by a rubber washer was placed in a special adaptor which was clamped to the top half of an Elford ultralter (ref 6) by means of a hexagonal nut Pressure was applied to the system and increased slowly until the membrane was ruptured The inimum pressure required to break the membrane is recorded in column 5 or 10 The rate of flow of water (*RFW*), specific water content WC) and average pore diameter (*APD*) were determined by the methods described by Elford and Ferry (ref 7)

Brown[1] has graded collodion membranes, after oagulation in water, by immersing them in mixtures f ethyl alcohol and water in varying proportions nsuccessful attempts were made in this laboratory o swell dried 'Gradocol' membranes by similar ethods using various alcohols

'Gradocol' membranes of porosities ranging from mμ to 2,000 mμ were dried by treatment with either thyl, *n*-propyl, *iso*propyl, *n*-butyl, *iso*butyl or amyl lcohol, followed by either chloroform, carbon tetrahloride, dichlorethylene, benzene or petroleum ether. or the whole range of porosities, only *iso*butyl or myl alcohol could be used successfully in combinaion with petroleum ether (preferably of boiling point 0–60° C) for drying the membranes without impairent to their characteristics (Table 2) (cf. Grabar[2])

The membrane to be dried (4 0 cm or 5 6 cm. in iameter, weighing 0 05–0 1 gm) was placed between olds of filter paper to remove superficial water, and hen immersed in 50 ml *iso*butyl or amyl alcohol t was transferred twice to approximately 50 ml fresh lcohol in separate closed vessels for 5–10 min ntervals Then the superficial alcohol was removed ith filter paper and the membrane washed three imes with petroleum ether in a similar manner The embrane was dried at room temperature or 60° C.

Collodion particles used for adsorption studies were obtained, either by the Loeb method[3] or by grinding under water in a ball-mill thin strips of those normally discarded portions of 'Gradocol' membranes prepared by the Elford technique[4]. The nitrocellulose particles prepared by the latter method were graded, when dry, by passage through a No 100 B S S sieve. They were then shaken with water in a stoppered cylinder and separated from finer particles by decantation This process was repeated until the supernatant was clear The collodion particles were activated by the method described by Sollner, Abrams and Carr[5].

Membranes or nitrocellulose particles treated by the method described above may be stored or transported in the dry state The membranes may be marked with Indian ink and stored in the dark for many months in paper envelopes or glass vessels together with others of different porosity When re-equilibrated against water, their characteristics remain unchanged from the original, that is, thickness, rate of flow of water, mechanical strength, specific water content and porosity remain unaltered (see Table 2)

Such dried membranes of predetermined characteristics may be sealed, by means of a 5 per cent solution of nitrocellulose shreds in ether alcohol (1 1) mixture, to the end of a narrow tube to make a filter stick or a wide tube (for example, a Gooch crucible adaptor) for use in dialysis.

S JACOBS

Wright–Fleming Institute of Microbiology,
St Mary's Hospital,
London, W 2.

Sept 23

[1] Brown, N , *Biochem J* , **9**, 591 (1915)

[2] Grabar, P , Cold Spring Harb Symp Quant Biol , **6**, 252 (1938), *Actualités Sci Indust* , 957, 43 (1943)

[3] Loeb, J , *J Gen Physiol* **5**, 109 (1922–23)

[4] Elford, W J , *J Path Bact* , **34**, 505 (1931)

[5] Sollner, K , Abrams, I , and Carr, C W , *J Gen Physiol* , **25**, 7 (1941–42)

[6] Elford, W J , and Barnard, J E , *Proc Roy Soc* , B, **109**, 360 (1931)

[7] Elford W J , and Ferry, J D , *Brit J Exp Path* , **16**, 1 (1935)

Chromatography and Paper Electrophoresis of Sulphonphthalein Dyes

Two of the sulphonphthalein dyes, bromophenol blue[1] and bromocresol green[2], have been used widely for the detection of protein after electrophoresis on filter paper The uptake of bromocresol green by protein under these conditions has been studied recently by Franglen and Martin[3] Extending this work, the purity of other sulphonphthalein dyes has been investigated with paper chromatography and filter paper electrophoresis , the methods used and the results obtained are described below.

The dyes examined are listed in Tables 1 and 2, and were supplied by the British Drug Houses, Ltd , as a grade suitable for *p*H determination These were made up as 2 per cent (w/v) solutions in absolute ethanol , all the dyes went completely into solution

The positions of the dyes after chromatography or electrophoresis were determined by inspection under normal light, and under ultra-violet light of 2537 A given by a Hanovia 'Chromatolite' Under ultra-violet light, bright fluorescence was observed in all the dyes except in those containing substituted *m*-cresol rings , these, in contrast, were markedly absorbent

For chromatographic analysis, the solutions were applied as 20-µl spots by an 'Agla' microsyringe to sheets of Whatman's filter paper No 3 *MM* A number of different developing systems were tried , the following pair were found to be the most satisfactory In the first, the paper was equilibrated over-night with purified *tert* -amyl alcohol and concentrated ammonia solution (spec. grav 0 880), and was developed by descending chromatography with the following mixture purified *tert* -amyl alcohol, 200 ml , and concentrated ammonia solution (analytical reagent grade, spec grav 0 880), 50 ml The chromatogram was run for 26 hr , during which the front advanced about 31 cm past the original positions of the spots In the second set of conditions, the paper was equilibrated over-night with purified *tert* -amyl alcohol, glacial acetic acid and water, and was developed with a solution containing purified *tert* -amyl alcohol, 200 ml , glacial acetic acid (analytical reagent grade), 50 ml , and distilled water, 50 ml The chromatogram was run for 26 hr , during which the front advanced about 34 cm past the original positions of the spots

The results are shown in Table 1, in which the R_F of each main component is noted, together with the number of other components detected In most of the dyes, these other components are present small quantities, the majority of them being detec only by their fluorescence under ultra-violet lig In the case of chlorophenol red, however, the se other components form a large part of the sam and four of them are clearly visible on the chroma gram under normal light One of the compone separated from the chlorophenol red sample appea to be identical with bromophenol blue, both chromatography in the two different develop systems described and by paper electrophoresis

Table 1 CHROMATOGRAPHIC ANALYSIS OF SULPHONPHTHALEIN DYES ON WHATMAN'S NO 3 *MM* FILTER PAPER

Dye	Developing system			
	Amyl alcohol – ammonia		Amyl alcohol – acetic acid	
	R_F of main component	No of other components	R_F of main component	No of other components
Bromophenol blue	0 27	1	0 74	0
Bromocresol green	0 32	1	0 79	0
Chlorophenol red	0 09	6	0 67	6
Bromophenol red	0 11	4	0 68	5
Bromocresol purple	0 19	2	0 76	5
Bromothymol blue	0 50	0	0 88	0
Phenol red	0 06	4	0 54	3
Cresol red	0 12	4	0 67	3
Metacresol purple	0 16	3	0 66	2
Thymol blue	0 70	0	0 85	0

Table 2 ELECTROPHORETIC ANALYSIS OF SULPHONPHTHALEIN DYE WHATMAN'S NO 4 FILTER PAPER IN 0 06 *M* DIETHYLBARBITU BUFFER, *p*H 8 6

Dye	Mobility of main component (cm^2/V sec × 10^5)	No of other components
Bromophenol blue	12 8	0
Bromocresol green	13 5	0
Chlorophenol red	14 4	3
Bromophenol red	13 8	1
Bromocresol purple	13 4	2
Bromothymol blue	11 9	0
Phenol red	13 8	3
Cresol red	12 2	3
Metacresol purple	12 2	0
Thymol blue	9 0	0

In both chromatographic systems, all the co ponents formed compact spots, except those bromophenol blue and the 'bromophenol blue' s in the chlorophenol red sample In the latter cas pronounced tailing occurred in the amyl alcoh ammonia run Earlier observations suggest that t tailing is due to a gradual and irreversible breakdo of bromophenol blue in alkaline conditions[3] breakdown was observed in any of the other dyes either of the systems

For electrophoretic analysis, the dye solutic were applied as 5-µl spots to a sheet of Whatma No 4 filter paper. Electrophoresis was carried in an apparatus similar to that described by Frangle using 0 06 *M* diethylbarbiturate buffer, *p*H 8 6, a applying a potential difference of 8 0 V /cm 3 hr

The results of electrophoresis are shown in Table In calculating the rates of migration of the dy endoelectrosmosis has been taken into account T was determined from the movement of a spot dextran solution included in the run[4]

These analyses show that sulphonphthalein d can be readily distinguished from each other filter-paper techniques Chromatography was fou to be more effective in most cases than electrophores the latter method, however, enables bromophe red to be separated from cresol red It is also appar from these analyses that the majority of the samp tested have appreciable quantities of impurities T may prove to be of importance in their use for t semi-quantitative determination of *p*H

I wish to thank Prof N. H Martin for his enco agement during this work, and to acknowledge t financial help given by the Research Fund of George's Hospital

G T FRANGLEN

Department of Chemical Pathology,
St George's Hospital Medical School,
London, S W 1

Sept 23

[1] Cremer, H D , and Tiselius, A , *Biochem Z* , **320**, 273 (1950)
[2] Franglen, G T , *J Clin Path* , **6**, 183 (1953)
[3] Franglen, G T , and Martin, N H , *Biochem J* , **57**, 626 (1954)
[4] Kunkel, H G , and Tiselius, A , *J Gen Physiol* , **35**, 89 (1951)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 17

Society of Chemical Industry (joint meeting of the **Agriculture** nd **Pesticides Groups**, at the Chemical Society, Burlington House, ccadilly, London, W 1), at 5 30 p m —Mr J T Martin and Mr V Coles "The Analysis of Insecticides—Tar Oils and Summer ls", Mr K Gardner "The Analysis of Weedkillers—MCPA and noseb"

University of London (in the Anatomy Theatre, University llege, Gower Street, London, W C 1), at 5 30 p m —Prof W H cisz (University of Groningen) "Problems of Transport in Plants" urther Lectures on January 19 and 21)*

Institute of Metal Finishing (at the Northampton Polytechnic, John Street, London, E C 1), at 6 15 p m —Mr V F Henley ome Aspects of Sulphuric Acid Anodising to Specification D T D 0C"

Pharmaceutical Society of Great Britain (at 17 Bloomsbury quare, London, W C 1), at 7 30 p m —Dr Douglas McKie "The igins of Chemistry—Alchemy or Technology ?"

Tuesday, January 18

University College, London (in the Anatomy Theatre, Gower treet, London, W C 1), at 1 15 p m —Prof J Z Young, F R S The Counting of Microscopic Particles" *

Institute of Physics, Electronics Group (at 47 Belgrave quare, London, S W 1), at 5 30 p m —Dr R F Saxe "Millimicroecond Techniques"

Institution of Chemical Engineers (at the Geological Society, urlington House, Piccadilly, London, W 1) at 5 30 p m —Mr R C Pratt and Mr J A McWilliams "Performance Data for xpanded Metal Column Packing", Mr F Knelmann, Mr N ombrowski and Prof D M Newitt "The Mechanism of Drop ormation from Gas or Vapour Bubbles"

Institution of Electrical Engineers, Measurements Section t Savoy Place, London, W C 2), at 5 30 p m —Discussion on "The uman Operator in Closed Loop Control Systems"

Society of Chemical Industry, Agriculture Group (at the hemical Society, Burlington House, Piccadilly, London, W 1), at 30 p m —Dr C Bloomfield "Leaf Leachates as a Factor in edogenesis"

Scientific Film Association (in the Shell Film Theatre, Shellex House, Strand, London, W C 2), at 6 30 p m —Mr Trevor letcher "Cinemathematics"

Society for Analytical Chemistry, Physical Methods Group t the Iron and Steel Institute, 4 Grosvenor Gardens, London, S W 1), t 6 30 p m —Papers on "Solvent Extraction"

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), t 7 p m —Dr E G West "Manufacture of Integral Structures"

Wednesday, January 19

Royal Society of Arts (at John Adam Street, Adelphi, London, C 2), at 2 30 p m —Dr W Idris Jones "Research in the Coal ndustry" (Cadman Memorial Lecture)

Royal Meteorological Society (at 49 Cromwell Road, South ensington, London, S W 7), at 5 p m —Discussion meeting on "Airow Over Mountains" *

Royal Statistical Society (at the London School of Hygiene nd Tropical Medicine, Keppel Street, London, W C 1), at 5 15 p m —Mr Philip Redfern "Net Investment in Fixed Assets in the nited Kingdom, 1938–1953"

Eugenics Society (at the Royal Society, Burlington House, iccadilly, London, W 1), at 5 30 p m —Prof L S Penrose, F R S The Genetics of Microcythaemia (Thalassaemia)" *

Institution of Electrical Engineers, Education Discussion ircle (at Savoy Place, London, W C 2), at 6 p m —Discussion on Education and Training for Engineers and Craftsmen in France"

Royal Institute of Chemistry (joint meeting with the **London ection** of the **Society of Chemical Industry**, in the Chemistry ecture Theatre, King's College, Strand, London, W C 2), at 6 30 p m —Prof M Stacey, F R S "Some Recent Advances in Organic hemistry"

Thursday, January 20

Bone and Tooth Society (at the Institute of Orthopædics, 234 reat Portland Street, London, W 1), at 5 p m —Symposium on Fluorosis"

Linnean Society of London (at Burlington House, Piccadilly, ondon, W 1), at 5 p m —Miss D J Jackson "The Capacity for light of Water Beetles, with Observations on Various Species ccurring in the Western Scottish Isles", Dr W A Clark "Plant istribution in the Western Isles"

Institute of Fuel (at the Institution of Civil Engineers, Great eorge Street, London, S W 1), at 5 30 p m —Discussion on "The eaver Report of the Committee on Air Pollution" *

University College, London (in the Electrical Engineering heatre, Gower Street, London, W C 1), at 5 30 p m —Prof F Brailsord "The Domain Theory of Ferromagnetism" (Further Lectures n January 27 and February 3)*

Institute of Physics, Education Group (at 47 Belgrave Square, ondon, S W 1), at 6 p m —Prof Norman Ramsey "The Training f Physicists in the United States of America"

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London S W 1), at 6 p m —Mr Y W Rayden "Plastics in the Building Industry"

Chemical Society (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S W 7), at 7 30 p m —Prof H C Longuet-Higgins "The Role of the π-Electron in Aromatic Chemistry" (Tilden Lecture)

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W 1), at 7 30 p m —Symposium on "Loiasis"

British Institute of Radiology, incorporated with the **Rontgen Society** (in the Reid-Knox Hall, 32 Welbeck Street, London, W 1), at 7 45 p m —Special General Meeting, followed by Scientific Papers

British Psychological Society, Social Psychology Section (in the Eugenics Theatre, University College, Gower Street, London W C 1) at 8 15 p m —Prof T H Pear "Etiquette, Manners and Good Will"

Friday, January 21

Society of Chemical Industry Corrosion Group (in the Great Hall of Battersea Polytechnic, Battersea Park Road, London, S W 11), at 10 a m —Exhibition—"Corrosion Prevention in the Home" *

Royal Geographical Society (joint meeting with the **Institute of Navigation**, at 1 Kensington Gore, London, S W 7), at 5 p m —Mr Frank Evans "Transatlantic Drift"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Scientific Officer, Grade 1 (with a university degree of high standard in physics or equivalent qualifications, and preferably with some experience in optical instrumentation), **in the Instrumentation Section** of the Aeronautical Research Laboratories (Department of Supply—High Speed Aerodynamics Division), Salisbury, South Australia, for the development and design of general physical and particularly optical instruments for aerodynamics research—Senior Representative (A P 23), Department of Supply, Australia House, Strand, London, W C 2 (January 20)

Analytical Chemist (with an appropriate degree or Associate of the Royal Institute of Chemistry, and preferably with some experience in an industrial laboratory) in the Central Laboratory—Chief Personnel Officer, North Western Gas Board (Liverpool Group), Radiant House, Bold Street, Liverpool 1 (January 24)

Agronomist, Grade 3 (with a degree in agriculture or equivalent qualifications, and experience in agronomic research and commercial rubber planting), in the Public Service of the Territory of Papua and New Guinea—The Official Secretary, Australia House, The Strand, London, W C 2 (January 31)

George Angus Student (graduate of an approved university or holder of approved qualifications) for postgraduate research in the Department of either Chemistry, Physics or Mechanical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (January 31)

Lecturer in Animal Nutrition in the Department of Veterinary Hygiene and Animal Husbandry—Secretary, Royal Veterinary College, Royal College Street, London, N W 1 (January 31)

Research Officer (with an honours degree in science with botany and chemistry as major subjects, or in agricultural science or equivalent qualifications) **in the Plants and Soils Laboratory**, Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization, Brisbane, Queensland, to undertake studies on the factors limiting legume establishment in the sub-tropical areas and Southern Queensland—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting 146/34 (February 5)

Senior Lecturer in Physics, and a **Lecturer in Mathematics**, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W C 1 (February 7)

Reader in Electrical Engineering at the University of Adelaide, Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Adelaide, February 14)

Lecturers in Engineering—The Registrar, The University, Manchester 13 (February 15)

Lecturer or **Assistant Lecturer** (with special interests in genetics or genecology) **in Botany**—The Registrar, The University, Leeds 2 (February 19)

Assistant (with a degree in agriculture or equivalent qualifications and preferably at least two years postgraduate experience) **in the Agricultural Section**—The Director, Tea Research Institute of East Africa, P O Box 91, Kericho, Kenya Colony (February 28)

Head (with high qualifications in geology and experience in both teaching and research) **of the Department of Geology**—The Principal, Chelsea Polytechnic Manresa Road, London, S W 3 (February 28)

University Lecturer, and **University Demonstrators** (2) **in Chemical Engineering**—The Appointments Committee of the Department of Chemical Engineering, Tennis Court Road, Cambridge (March 11)

Research Officer (with at least an honours degree in metallurgy or metallurgical engineering, or equivalent qualifications) **in the Mechanical Engineering Research Laboratory**, South African Council for Scientific and Industrial Research, Pretoria, for research work in the field of ferrous and non-ferrous physical metallurgy—South African Scientific Liaison Officer, Africa House, Kingsway, London, W C 2 (Pretoria, March 15)

I C I Research Fellows in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology, Physics or allied subjects—The Academic Registrar, University of London, Senate House, London, W C 1 (April 16)

Turner and Newall Research Fellows in Engineering, Inorganic Chemistry, Physics or an allied subject—The Academic Registrar, University of London, Senate House, London, W C 1 (April 16)

Aerodynamicists and Aeronautical Engineers, Scientific Officer grade (with a first- or second-class honours degree in engineering, physics or mathematics, and preferably with some research or experimental experience of aircraft problems) at the Ministry of Supply Aeroplane and Armament Establishment, Amesbury, Wilts, National Gas Turbine Establishment, near Farnborough, Hants, Royal Aircraft Establishment, Farnborough, Hants, and at London H Q—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 354/54A

Agricultural Education Officer (with a degree in agriculture and experience in teaching), in Basutoland, to take administrative and academic charge of a new training centre for subordinate staff of the Agricultural Department—The Director of Recruitment, Colonial Office, Great Smith Street, London, S W 1, quoting BCD 63/76/07

Assistant Professor (with a special interest in low temperature research) in the Department of Physics—Prof W H Watson, University of Toronto, Toronto, Canada

Associate Professor of Physics—The President, Memorial University of Newfoundland, St John's, Newfoundland, Canada

Chemist, Experimental Officer grade (preferably with experience of analytical work in any field), in the Department of Insecticides and Fungicides, for general analytical work and assisting in developing analytical methods for determining insecticides in soil and in plant materials—The Secretary, Rothamsted Experimental Station, Harpenden, Herts

Chemist (with a degree in natural science, and preferably postgraduate experience, particularly in soil survey work) in the Agricultural Department, Sierra Leone, to make a soil survey of part of the Northern Province of Sierra Leone, with particular reference to the nutrient status and fertilizer requirements of soils suitable for mechanized rice cultivation—The Director of Recruitment, Colonial Office, Great Smith Street London, S W 1, quoting CDE 63/15/04

Chemists (with at least H N C in chemistry or equivalent qualifications) to develop and apply methods of analysing biological and other materials for very low levels of radioactivity—Establishments Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell Didcot, Berks, quoting 2/103/217

Experimental Officer or Assistant Experimental Officer (with at least H S C (science) or equivalent and preferably with some experience in the handling of explosives together with some knowledge of electronics), at Fort Halstead, Kent, to perform experimental physical research using small explosive charges and high-speed recording equipment—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 146/WGE/2

Lecturer (with experience in wind tunnel research work) in the Department of Aerodynamics—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks

Plant Pathologist (graduate in pure or applied botany) in the Hop Research Department—The Registrar, Wye College, Wye, Kent

Research Assistant (preferably with previous experience in metallurgical analysis) to assist in experimental work connected with the chemistry of steel making, and to carry out analysis of metals and slags—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1, quoting "Analysis"

Scientific Officer (with a first- or second-class honours degree in physics or electrical engineering, or equivalent qualifications), at the R A F Station, near High Wycombe, Bucks, for operational research duties, theoretical studies and development work in the field of communications and general electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 109/54A

Scientific Officer (with a degree in chemistry or equivalent), at the Ministry of Agriculture and Fisheries, Tolworth, Surrey, for general chemical and analytical work connected with chemical methods for the control of various animal pests and insects on stored products—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting F 679/54A

Senior Experimental Officer (preferably with a pass degree in chemistry, and previous experience of the control of staff and of work on explosives) to advise technical and scientific staff on safe working in laboratories, pilot plant, and production units associated with a wide range of chemical and physical research problems—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks quoting 336/WGE/2

Technical Assistants (with Inter B Sc or equivalent qualification) at the Central Laboratory, Chiswick—The Staff Officer (F/EV 519) London Transport, 55 Broadway, London, S W 1

Technician (with a sound knowledge of routine hæmatology procedures)—The Secretary, The Laboratory, Peace Memorial Hospital, Watford, Herts

Technician (with experience in the main branches of histological technique and also in photomicrography) in the Histology Laboratory—The Registrar, The University, Bristol 8

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London Series A Mathematical and Physical Sciences No 925, Vol 247 (4 November 1954) The Lift and Moment Acting on a Thick Aerofoil in Unsteady Motion By L C Woods Pp 131–162 10*s* No 296, Vol 247 (4 November 1954) On the Decay of a Normally Distributed and Homogeneous Turbulent Velocity Field By I Proudman W H Reid Pp 163–189 8*s* 6*d* (London Royal Society, 1954)

British Museum (Natural History) Economic Series No 1 House-Fly as a Danger to Health—Its Life History and How to with It Sixth edition Pp iii+17 (London British Museum (Nat History), 1954) 9*d*

Bulletin of the British Museum (Natural History) Entomol Vol 3, No 9 The *Protoptila* Group of the Glossosomatinae (Tricl tera Rhyacophilidae) By Martin E Mosley Pp 315–346 Zoology Vol 2, No 7 On the Polyzoan Genus *Crepidaca* Levinsen By David Alexander Brown Pp 241–263 Vol 2, No Subdivisions of the Genus *Ptilinopus* (Aves, Columbae) By Ar James Cain Pp 265–284+2 plates 8*s* (London British Mus (Natural History), 1954)

Privy Council Medical Research Council Special Report Series 287 Studies on the Nutritive Value of Bread and on the Effec Variations in the Extraction Rate of Flour on the Growth of Un nourished Children By E M Widdowson and R A McCa Pp viii+137+1 plate (London H M Stationery Office, 19 8*s* 6*d* net

Society of Chemical Industry Proceedings of the Plastics Polymer Group Vol 5, 1953 Pp iii+152 (London Societ Chemical Industry, 1954) 50*s* (12*s* 6*d* to members of group)

Discovery Reports Vol 27 Pp 219–234, The Planktonic Deca Crustacea and Stomatopoda of the Benguela Current Part 1 Survey, R R S *William Scoresby*, March 1950 By Dr Marie Lebour (Cambridge At the University Press, 1954) 6*s* 6*d* net

Register of Research in the Social Sciences in Progress and in P No 11 1953–1954, with a Directory of Research Institutions Ed by Feodora Stone Pp vii+168 (London Cambridge Univer Press, 1954) 25*s* net

Agricultural Research Institute of Northern Ireland Twe Seventh Annual Report, 1953–54 Pp 38 (Hillsborough, Co Do Agricultural Research Institute of Northern Ireland, 1954)

Forestry in Northern Ireland Pp 20 (Belfast Ministry Agriculture, 1954)

Other Countries

United States Department of Agriculture Forest Service Circ No 944 Biology and Control of the Engelmann Spruce Beetl Colorado By C L Massey and N D Wygant Pp i+35 (Washing D C Government Printing Office, 1954) 20 cents

Metropolitan Life Insurance Company Statistical Bulletin, Vol No 9 Family History and Longevity Pp 12 (New York Me politan Life Insurance Company, 1954)

Sudan Government Wellcome Chemical Laboratories Med Services—Ministry of Health Report of the Government Analyst the period 1 7 1953–30 6 1954 Pp 24 (Khartoum Ministry Health, 1954)

United States Department of Commerce National Bureau Standards Circular No 556 Thermal Conductivity of Metals Alloys at Low Temperatures a Review of the Literature By Rol L Powell and William A Blanpied Pp iv+68 (Washington, D Government Printing Office, 1954) 50 cents

Koninklijk Nederlands Meteorologisch Instituut Mededelingen Verhandelingen No 59 Tien Wetenschappelijke Bijdra Uitgegeven bij het Honderdjarig bestaan van het K N M I (W English summaries) Pp ii+267–464 12,50 florins No 60 Na keurigheid en Betrouwbaarheid van Temperatuur- en Vochtighe bepalingen in Buitenlucht met Behulp van Kwikthermomet By Dr C Kramer, Dr Ir J J Post en Dr J P M Woudenb Pp 60+4 plates No 61 Some Aspects of the Influence of the Ear Surface on the Atmosphere By Dr J A Businger Pp xii+ 4 florins (Gravenhage Staatsdrukkerij- En Uitgeverijbed 1954)

Koninklijk Nederlands Meteorologisch Instituut Seismic Record De Bilt No 37 1949 Pp vii+30 (Gravenhage Staatsdrukke En Uitgeverijbedrijf, 1954) 1 florin

Transactions of the American Philosophical Society New Ser Vol 44, Part 5 (1954) An Early Archaeological Site near Panu Vera Cruz By Richard S MacNeish Pp ii+539–642 (Philadelph American Philosophical Society, 1954) 2 dollars

Jahrhundertfeier der Geburtstage von Paul Ehrlich und Emil Behring Ein Bildbericht von den Festlichen Tagen in Frankf Main, Marburg-Lahn und Hoechst am 14, 15 und 16, März, 19 Pp 40 (Frankfurt (M) Farbwerke Hoechst AG, vormals Meis Lucius and Bruning, 1954)

Unión Nacional de Periodistas Alfabetización y Educación Adultos Decalogo Para la Conservacion de las Tierras Agrico Por Dr M Acosta Solis Pp 19 (Quito, Equador Dr M Aco Solis (P O Box 408), 1954)

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO, LTD,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare Lond

Annual subscription £6, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd, Crown House, 143–147 Regent Street, London, W
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Offi

New Books

Electrolyte Solutions

By R A ROBINSON, D Sc, Ph D, F R I C, Professor of Chemistry, University of Malaya, Singapore, and R H STOKES, Ph D, D Sc, F R A C I, A R I C, Reader in Physical Chemistry, University of Western Australia

A detailed account of the present state of knowledge of some of the most fundamental properties of electrolytes, conductance, chemical potential and diffusion, from the standpoint of the practical electrochemist

Modern experimental methods are discussed at some length, and extensive results are given, together with numerous tables useful in computations on electrolyte solutions

Price 56*s*

Chemisorption

By B M W TRAPNELL, M A, Ph D, Lecturer in Chemistry, University of Liverpool

This book is designed to give a balanced presentation of the subject of chemisorption, in particular of discoveries made over the last fifteen years, but hitherto only available as original papers scattered over many journals The main aspects of the subject are discussed, but the treatment is selective in that the author has concentrated on those features which are best understood in our present state of knowledge

The main part of the book, concerned with chemisorption itself, treats velocities of adsorption and desorption, equilibrium at surfaces, heats and mechanisms of adsorption, and the mobility of adsorbed layers Then since chemisorption is also of interest to chemists in its relationship to heterogeneous catalysis, the two final chapters show how studies of the former can contribute to understanding of the latter In these chapters the causes of catalytic specificity are discussed, together with the mechanisms of some simple catalytic reactions, including olefine hydrogenation and the cracking of hydrocarbons

Price 35*s*

BUTTERWORTHS SCIENTIFIC PUBLICATIONS
88 KINGSWAY LONDON W.C.2

The Policy for Children

£12 a year invested for a child will provide benefits at age 18, 21, or 25. The investment may be made by a parent or friend.

e.g. If the investment is begun within two months of birth it will provide, at age 21, £323 in cash, or a life policy for £1,656.

The Equitable Life Assurance Society

(founded 1762)

19, Coleman Street, London, E C 2.

No shareholders No commission

L. LIGHT & CO. LTD.

Latest additions to our list—

Acid Phosphatase (wheat germ) 750 units per mg	95/- G
N-Benzoylphenylhydroxylamine	25/- D
Brassylic acid	25/- D
Carnosinase	138/- d
*cyclo*Hexylamine carbonate	52/- K
*cyclo*Pentyl bromide	56/- H
Dimercaptothiadiazole	26/- D
1, 1′-Dinaphthylamine	56/- D
Heptyne-1	29/- D
Hydrinden	51/- H
Lithium pyruvate	25/- G
Nitrin (o-aminobenzalphenylhydrazine)	25/- D
1-Nitro 2-aminoanthraquinone	20/- D
3-Nitro-2-aminoanthraquinone	20/- D
Octyne-1	31/- D
Pyridazine	30/- G
Peserpine (alkaloid cryst)	62/- d
Stilbazo	18/- G
Tyrosinase (polyphenol oxidase)-grey, soluble lyophiled powder	
Type A = 2-3 cresolase units/mg, 7-8 catecholase units/mg	150/- d
Type B = 3-4 cresolase units/mg, 4-5 catecholase units/mg	150/- d
Zincon (2-carboxy-2′-hydroxy-5′-sulphoformazyl benzene)	35/- G

POYLE TRADING ESTATE, COLNBROOK
near SLOUGH . BUCKS ENGLAND
Telephone Colnbrook 262/3

LECTURES AND COURSES

UNIVERSITY OF LONDON

A course of three lectures on "Approximate Solution of Boundary Value Problems in Mathematical Physics by the Method of the Hypercircle in Function-Space" will be given by Professor W Prager (Brown University) at 5 30 p m on January 24, 27 and 28 at King's College Strand W C 2

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive unless he or she, or the employment is excepted from the provisions of the Notification of Vacancies Order,* 1952

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

METALLURGIST RESEARCH OFFICER

Applications are invited for a post as Research Officer in the Mechanical Engineering Research Laboratory of the C S I R, Pretoria South Africa The salary scale associated with this post is £780 by £48 to £1 020 per annum In addition a cost-of-living allowance of £234 per annum is payable to married male officers Starting salary according to qualifications and experience Generous leave privileges and five-day week Candidates must be in possession of at least an honours degree in metallurgy or metallurgical engineering or equivalent qualification The successful candidate will do research work in the field of ferrous and non-ferrous physical metallurgy The successful candidate will be required to furnish a medical certificate of good health and to become a member of the University Institutions Provident Fund The Council will bear the transportation costs of the appointee and his family from his place of residence to Pretoria Further information and application forms are obtainable from the South African Scientific Liaison Officer Africa House, Kingsway, London W C 2

Applications, giving full details of age marital status qualifications, experience, and the names of referees, must reach the Secretary/Treasurer, C S I R P O Box 395, Pretoria South Africa before March 15 1955 A copy of the application must be sent to the South African Liaison Officer in London

CHELSEA POLYTECHNIC

MANRESA ROAD, S W 3

HEAD OF DEPARTMENT OF GEOLOGY

The Governors invite applications for the post of Head of the Department of Geology, which becomes vacant through the retirement of Dr W F Fleet Candidates should possess high qualifications in geology, and have had experience in both teaching and research Salary scale Grade II (men £1 065 by £25 to £1,215, women £852 by £20 to £972) plus London allowance of £36 or £48, according to age Duties to commence September 1 1955

Further particulars and form of application may be obtained by sending stamped addressed foolscap envelope to the undersigned, to whom applications must be returned not later than February 28, 1955

N M H LIGHTFOOT, M A F R S E
Principal

A RESEARCH FELLOWSHIP OF £750 PER annum renewable annually for a period of three years and tenable at the Chemical Research Laboratory of the Department of Scientific and Industrial Research, Teddington is offered by the Forestal Land Timber & Railways Co Ltd The research will be directed to investigating the function of tannins in preventing corrosion of metals and the results could be made available for a higher degree Applicants should have as a minimum qualification a good honours degree in chemistry and preferably some research experience They should have a particular interest in applying fundamental physical chemistry and physical methods of organic chemistry to problems of industrial importance —Applications, with references should be sent to the Chief Research Chemist, Forestal Central Laboratory, Harpenden Herts

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

WEAPONS GROUP, ALDERMASTON, BERKS

Requires Experimental Officers and Assistant Experimental Officers to assist in the preparation of experimental equipment and in the carrying out of nuclear physics experiments The minimum qualification is higher school certificate (science) or equivalent, but for Experimental Officer posts (minimum age 26 years), possession of a pass degree is desirable Previous experience, although not essential would be advantageous The salary scales are Experimental Officer, £715 to £880 (male) per annum and Assistant Experimental Officer, £288 10s (at age 18) to £640 (male) per annum The successful applicant will be required to join the Authority's Principal Superannuation Scheme to be introduced shortly, and the salary scales quoted above will be enhanced to cover contributions Houses will be available within a reasonable period for married officers who live outside the Establishment's transport facilities

Application form from Senior Recruitment Officer, A W R E, Aldermaston, Berks Quote Ref 349/W G E /34

UNIVERSITY OF LEEDS

Applications are invited for Imperial Chemical Industries Limited Research Fellowships in Bacteriology, Biochemistry, Biomolecular Structure Botany (Plant Biochemistry and Biophysics) Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying) Pharmacology, Physics, Physiology or Textile Industries (Protein Chemistry and Wool Textile Engineering) The Fellowships will be of an annual value within the range £600 to £900 a year according to qualifications and experience and will normally be tenable for three years

Further particulars can be obtained on request Three copies of applications (one in the case of applicants from overseas), together with the names of two referees, should reach the Registrar, The University, Leeds, 2, not later than April 15, 1955

UNIVERSITY OF BRISTOL

DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for a Lectureship (Grade III or II) in the Department of Civil Engineering Applicants should have a good honours degree and some relevant experience, preferably including some research experience in the field of structures or soil mechanics

Applications, including the names of two persons to whom reference may be made should be sent not later than January 31, 1955, to the Registrar The University Bristol 8 from whom further particulars may be obtained

BEDFORDSHIRE EDUCATION COMMITTEE

LUTON COMMITTEE FOR EDUCATION
LUTON AND SOUTH BEDFORDSHIRE
COLLEGE OF FURTHER EDUCATION
Principal W F Stephenson, B Sc, F R I C

Assistant (Grade B) required to organize and teach Geology and Geography to the standard of General B Sc (London) Duties to commence in April The Department is developing rapidly and there are wide opportunities for a person with initiative

Send s a e (foolscap) for application form which should be returned within two weeks of the appearance of this advertisement to J A Corbett Clerk of the Governors, 63-69 Guildford Street, Luton

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF CIVIL AND
MECHANICAL ENGINEERING

Applications are invited for the post of Senior Research Assistant Candidates should have a good honours degree in engineering, practical experience and/or research training Salary scale £550 by £50 to £900

Conditions of appointment and form of applications may be obtained from the undersigned

H PICKBOURNE,
Registrar

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG SOUTH AFRIC

Applications are invited for appointm the vacant post of Lecturer in Chemistry qualifications in inorganic and analytical c try will be a recommendation The subs salary scale attached to the vacant post by £50 to £1,150 The initial salary to b to the successful applicant will be dete in accordance with qualifications and expe In addition a temporary cost-of-living all is payable to married men, the present rat £234 per annum An allowance is made t the cost of travelling expenses Duties assumed March 1, 1955 or as soon as p thereafter

Further particulars and information as method of application may be obtained fr Secretary, Association of Universities British Commonwealth, 5 Gordon Square, don W C 1 The closing date for the of applications, in South Africa and Lon January 31, 1955

McMASTER UNIVERSITY

DEPARTMENT OF CHEMISTRY
GRADUATE ASSISTANTSHIPS

Applications are invited for part-time te and Research Assistantships from persons fied to register in courses leading to the and Ph D degrees in chemistry Assista normally carry a yearly stipend of $1, $1 600 Assistants are required to devot to ten hours per week to duties duri academic session (October to April inclusiv may devote full time to their research dur summer Research is in progress in th lowing fields mass spectrometry nuclear c try radiochemistry natural isotopic abu ratios and their biological and geological ficance isotope effects, organic reaction m isms physical chemistry of high-polymer tions isolation and structure of plant alk biogenesis of the thyroid hormone interm metabolism inorganic analytical methods

Interested persons should write to Dr Graham Chairman of the Department of C try Hamilton College McMaster Univ Hamilton Ontario Canada

UNIVERSITY OF MANCHEST

Applications are invited for posts of Le in Engineering Civil engineering cand should have particular interest in elas hydraulics or surveying, mechanical engin candidates should have particular interest i transfer, fluid mechanics thermodynamics a applied mechanics The present salary scal to £1 100 per annum but is under review salary according to qualifications and exper Membership of F S S U and children's allo scheme Applications will be considered engineers who would be interested in a tem appointment of two or more years

Applications should be sent not later February 15 1955 to the Registrar, The versity, Manchester 13, from whom further culars and forms of application may be obt

ST THOMAS'S HOSPITAL MEDICAL SCHOOL

A Lecturer in Applied Pharmacology and peutics is required by the Department of peutics Salary will be according to the sca a Junior Lecturer or Lecturer according t perience, with family allowance

Applications, giving full particulars an names of two referees should be sent February 8 to the Dean, St Thomas's Ho Medical School, London, S E 1

UNIVERSITY OF CAMBRIDG

FACULTY OF ENGINEERING

Amendment to notice in issue of ' Nat January 8, 1955

The closing date for applications for the advertised is February 9, 1955, and not Ja 21 1955

CHESTER BEATTY RESEARCH INSTIT (Institute of Cancer Research Royal C Hospital) Two Technicians required (a) chemical technician preferably with experien manometric techniques or in the isolatio natural products (b) Technician for ph chemistry laboratory, for work particularly cerred with spectroscopic techniques, exper in this field would be an advantage Both are permanent and superannuable, and the s will be according to age experience and qual tions —Applications, marked respectively " chemistry" and "Spectroscopy" should be dressed to the Chester Beatty Research Inst Fulham Road, London, S W 3

NRY AND CHARLOTTE PAYNE RESEARCH FELLOWSHIP

plications are invited by the Council of the al Society for a Henry and Charlotte Payne arch Fellowship in cytology and/or cyto- istry with special reference to malignant The Fellowship is tenable in any uni- ty hospital or medical school in the United dom or at any other place approved by ouncil of the Royal Society The appoint , will be for two years in the first instance April 1 1955 and may be renewed annu up to a total of five years It will be subject he conditions governing Royal Society Re h Appointments The stipend will be £1 000 annum with an annual increment of £50 with superannuation benefits to which the ssful candidate will be required to contri 5 per cent of annual stipend and to which Society will contribute a sum equivalent to er cent of the annual stipend

plications should be made on forms to be ned from the Assistant Secretary, The Royal ty, Burlington House London W 1, and ld be received as early as possible, in any not later than February 1 1955

OUNCIL OF SCIENTIFIC AND DUSTRIAL RESEARCH (INDIA)

plications invited for post of Director Cen- Electro Chemical Research Institute, Karai- (South India) in scale Rs 2 000 by Rs 100 s 2 500 per mensem (£1 800 by £90 to £2 250 annum approximately) Higher initial salary dered for exceptionally qualified candidate icants must possess wide research and ad- strative experience and ability to co-ordinate rch in the various divisions of the Institute cularly applied research Appointment will n the first instance for three or five years first-class passage for appointee and wife pplementary information and forms of appli- n from High Commission of India Establish- t Department, Aldwych London W C 2, ing 4/85K Last date for receipt of appli- ns February 8, 1955

UNIVERSITY OF READING

DEPARTMENT OF AGRICULTURAL BOTANY

pplications for a Lectureship in the above artment are invited from honours graduates otany or agricultural botany Preference be given to candidates with postgraduate rience in plant physiology ecology, genetics irus pathology Present salary scale (subject djustmen) £500 per annum rising by annual ments of £50 to £900 per annum F S S U family allowance

rther particulars may be obtained from the strar by whom applications should be re- d not later than April 15

BOROUGH POLYTECHNIC

BOROUGH ROAD S E 1

ARTMENT OF CHEMISTRY AND FOOD TECHNOLOGY

e governors invite applications from candi- s with degrees in chemistry (or chemical en- ering) for three assistant lectureships two in de B and one in Grade A Candidates should good academic qualifications with teaching esearch or industrial experience Following appointment the lecturers will be expected helped to acquire experience in one or two he following fields (i) Food science and nology (ii) Physical and colloid chemistry high polymer chemistry (iv) fats and sur- active agents (v) paint technology (vi) ical engineering There will be opportunities research leading to higher degrees

rther particulars of the posts, together with s on which to apply may be obtained from Principal

---

ONDON TRANSPORT INVITE APPLICA- for experienced chemists for Senior Scientific stant post Central Laboratory Chiswick, responsibility for section concerned with wide ty of analytical and investigational work ing with detergents cleaning materials efflu water treatment, weed killing disinfectants ticides adhesives fire extinguishing materials les and leathercloths, preparation and revision aterial specifications etc Good honours de or equivalent qualification experience in in- ry ability to prepare correspondence and re- s Salary range £980 by £25/£50 to £1 180 mencing salary according to qualifications experience medical exam contributory rannuation scheme after probation —Appli- ns to Staff Officer (F/EV 507) London sport 55 Broadway S W 1 For acknow- ment enclose addressed envelope

---

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

Vacancies exist in the South Wales Laboratory for honours graduates in physics metallurgy and electrical engineering to develop new processes for continuously applying protective coatings to steel strip at high speeds Some postgraduate research or industrial experience is desirable The laboratories are pleasantly situated in Singleton Park on the Gower coast side of Swansea Commencing salaries of up to £800 are offered according to age qualifications and experience Post is superannuated under F S S U

Written applications only quoting 'Coatings' to Personnel Officer, B I S R A 11 Park Lane London W 1

UNIVERSITY OF SYDNEY

AUSTRALIA

Applications are invited for the position of Lecturer/Senior Lecturer in Bacteriology Applicants with experience in dental bacteriology will be preferred The salary for a Lecturer is within the range of £A 1 100 to £A 1 450 per annum for a Senior Lecturer £A 1 500 to £A 1 750 per annum, with annual increments of £A 50 The salary is subject to deductions under the State Superannuation Act The commencing salary will be fixed according to the qualifications and experience of the successful applicant Finance available for home purchase under Staff Members Housing Scheme

Further particulars and information as to the method of application may be obtained from the Secretary Association of Universities of the British Commonwealth, 5 Gordon Square London W C 1 The closing date for the receipt of applications in Australia and London is February 26 1955

UNIVERSITY OF SYDNEY

AUSTRALIA

Applications are invited for the position of Lecturer in Plant Pathology The salary for a Lecturer is within the range of £A 1 100 to £A 1 450 per annum, with annual increments of £A 50 The salary is subject to deductions under the State Superannuation Act The commencing salary will be fixed according to the qualifications and experience of the successful applicant. Finance available for home purchase under Staff Members' Housing Scheme

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth 5 Gordon Square London W C 1 The closing date for the receipt of applications in Australia and London is February 26 1955

UNIVERSITY OF SYDNEY

AUSTRALIA

Applications are invited for the position of Systematic Botanist The appointee will be expected to lecture in such general courses in botany as required and to take responsibility for a small teaching and research herbarium Other things being equal preference will be given to an applicant whose research interests are in quantitative and experimental taxonomy The salary is within the range of £A 1 100 to £A 1 450 per annum with annual increments of £A 50 The salary is subject to deductions under the State Superannuation Act The commencing salary will be fixed according to the qualifications and experience of the successful applicant Finance available for home purchase under Staff Members' Housing Scheme

Further particulars and information as to the method of application may be obtained from the Secretary Association of Universities of the British Commonwealth, 5 Gordon Square London W C 1 The closing date for the receipt of applications, in Australia and London is February 26 1955

UNIVERSITY OF SYDNEY

AUSTRALIA

The Senate will shortly proceed to an appointment to the Chair of Anatomy Salary will be at the rate of £A 2 500 per annum There is a normal retirement provision under the Professorial Superannuation Scheme, and in addition a pension of not less than £A 400 per annum upon retirement after the age of sixty years Finance available for home purchase under Staff Members Housing Scheme The Senate reserves the right to fill the Chair by invitation

Further particulars and information as to the method of application may be obtained from the Secretary Association of Universities of the British Commonwealth 5 Gordon Square London W C 1 The closing date for the receipt of applications in Australia and London is March 1 1955

UNIVERSITY OF LIVERPOOL

Applications are invited for the following Fellowships (i) I C I Research Fellowships in Physics Chemistry Engineering Metallurgy and Pharmacology or any related subject to which some appointments may be made during the current academic year The appointments will date from October 1 1955 The salary will depend upon qualifications and experience but will normally be within the range £600 to £900 per annum together with F S S U benefits and family allowances (ii) Two Leverhulme Postgraduate Fellowships in the Faculty of Science tenable for one year at a value of £500 renewable for a second year at a value of £550

Applications three copies stating the Fellowship applied for age details of qualifications and experience publications research work in progress and completed and an outline of the proposed field of research and in the case of the Leverhulme Fellowships whether National Service requirements have been fulfilled together with the names of two referees, should be received not later than March 1 1955 by the undersigned from whom further particulars may be obtained (Candidates overseas who find it more convenient to do so may send one copy only by airmail)

STANLEY DUMBELL
Registrar

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

WEAPONS GROUP ALDERMASTON BERKS

Requires Nuclear Physicists in the grades of Senior Scientific Officer and Scientific Officer to work with a 6 Mev Van de Graaff generator and other accelerators There are excellent facilities for original research Applicants should have a first- or second-class honours degree in physics or an equivalent qualification but for the S S O posts some years' postgraduate research experience in nuclear physics is essential The salary ranges are Senior Scientific Officer £970 to £1 125 per annum and Scientific Officer £467 10s to £845 per annum but these will be enhanced to cover contributions to the Authority's Principal Superannuation Scheme which is to be introduced shortly Starting salary of Scientific Officers is assessed according to age qualifications and experience Houses available within a reasonable period for married officers who live outside the Establishment's transport facilities

Application form from Senior Recruitment Officer A W R E, Aldermaston Berks Quote ref 348/WGE/34

MAKERERE COLLEGE

THE UNIVERSITY COLLEGE OF EAST AFRICA

Applications are invited from graduates in agriculture with further qualification or special experience in agricultural engineering for (1) Lectureship or (2) Senior Lectureship in Agriculture (Farm Mechanization) Salary (1) £960 by £36 to £1 032 by £42 to £1,158 by £48 to £1 350 by £54 to £1 404 per annum (2) £1 450 by £50 to £1 650 per annum Cost of living allowance 10 per cent of salary (maximum £162 per annum) Child allowance £50 per annum (maximum £150 per annum) F S S U Rent according to quarters provided £45 to £85 per annum (including basic furniture) Paid passages for appointee and family (up to four adult passages) on appointment termination and leave (three months every two years) Duties to be assumed about July 1 1955

Applications (six copies) giving full qualifications and experience and names of three referees to be received by February 7 by Secretary Inter-University Council for Higher Education in the Colonies 1 Gordon Square London W C 1 from whom further particulars may be obtained

---

CHEMICAL SOCIETY

Assistant Librarian required immediately Minimum qualifications A L A Initial salary between £400 to £600 according to age and experience

Applications stating age education qualifications and experience to be addressed to the Librarian The Chemical Society Burlington House Piccadilly London W 1 Closing date fourteen days after insertion of this advertisement

---

BIOCHEMICAL TECHNICIAN AND JUNIOR Technician required in Surgical Unit Laboratory Salary Technician £470 to £545, Junior Technician at age 20 £240 rising to £380 Modern and very well equipped laboratory specializing in electrolyte metabolism including isotope studies —Applications stating age sex qualifications and experience should be sent to the Secretary St Mary's Hospital Medical School Paddington W 2

CANBERRA UNIVERSITY COLLEGE

Applications are invited for appointment to the Robert Garran Chair of Law, and the Chairs of Mathematics, Philosophy and Psychology Applications are also invited for appointment to the vacant posts of Senior Lecturer in Classics, Senior Lecturer or Lecturer in Economic History Senior Lecturer in Political Science (Public Administration), Lecturer in English, Lecturer in Mathematics, Lecturer in French, and Lecturer in Statistics (in the Department of Economics) Salary ranges are Professors £A 2 498 per annum , Senior Lecturers £A 1,498 to £A 1,748 per annum , Lecturers £A 1,098 to £A 1 448 per annum (including a cost of living adjustment at present £A 198 per annum) Commencing point within the range will be determined in accordance with the qualifications and experience of the applicant

Further particulars, conditions of appointment, and the summary form which must accompany applications may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1, or from the undersigned Applications close, in Australia and London, February 28, 1955

T M OWEN,
Registrar

Canberra University College,
Canberra, A C T ,
Australia

CITY OF CARDIFF EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY AND COMMERCE

Principal Dr A Harvey, B Sc , F Inst P

Applications are invited for the following posts (1) Head of the Department of Chemistry and Biology Applicants must have had good teaching experience and also good experience in chemical industry The salary will be in accordance with Grade III of the Burnham Report—i e , £1,215 by £25 to £1 365 The successful candidate will be required to take up duty on September 1, 1955 (2) Head of the Department of Engineering Applicants who should be either civil or mechanical engineers, must have good teaching and industrial experience The salary will be in accordance with Grade IV of the Burnham Report—i e , £1,365 by £25 to £1,515 The post is now vacant

Forms of application and further particulars of both of the above posts may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope and should be returned as soon as possible

ROBERT E PRESSWOOD,
Director of Education

City Hall,
Cardiff

LONDON HOSPITAL MEDICAL COLLEGE

(UNIVERSITY OF LONDON)

Applications are invited for the post of Demonstrator in Physiology which will shortly become vacant Initial salary, within scale £600 to £750 will be dependent on qualifications and experience (This scale is subject to alteration under the revised salary scales) The successful candidate will be eligible for membership of the F S S U and family allowances of £50 per annum for each child

Applications (three copies), together with the names of two referees, must be received by The Secretary, The London Hospital Medical College, Turner Street, E 1, within fourteen days of the appearance of this advertisement

LONDON TRANSPORT INVITE APPLICATIONS from science graduates with first- or good second-class honours degrees in mathematics or mechanical sciences for Scientific Assistant II post, Operational Research Section 55 Broadway Salary £520 to £800 (men) Commencing salary according to age, qualifications and experience Medical examination Contributory superannuation scheme after probation —Applications to Staff Officer (F/EV 513), London Transport, 55 Broadway, S W 1 For acknowledgement enclose addressed envelope

WAR DEPARTMENT REQUIRES TWO LECTURERS at R E M E Training Centre, Arborfield Qualifications An engineering or science degree , lecturing experience , and specialist knowledge of either electrical engineering or electronics, or survey mechanism Salary in accordance with Burnham Technical Scale for Assistant B with allowances for degree, other special qualifications and for extra working time compared with Technical Colleges Normal Teachers' Superannuation —Full particulars and application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London S W 1, quoting Ref D 679/54A

NATIONAL COAL BOARD

DURHAM DIVISION

Chemist with honours degree or equivalent required for work on plant and laboratory investigational problems concerned with the carbonization of coal Candidates with experience of research work preferred Starting salary according to qualifications and experience on scale of Scientist Grade III, £500 by £25 to £950

Applications, with full details, within ten days to Administrative Officer, Scientific Headquarters, National Coal Board Durham Division, 1-5 Forth Lane, Newcastle upon Tyne, 1

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

(UNIVERSITY OF READING)

A vacancy exists in the Nutrition Department for an Experimental Officer to assist in biochemical research involving chromatography and electrophoresis Previous experience would be an advantage Salary scale (men) £715 to £890, with superannuation

Graduates and others with equivalent qualifications may apply, giving the names of two referees, to the Secretary, N I R D , Shinfield, Reading Quote reference 55/2

UNIVERSITY OF HULL

Applications are invited for the Chair of Physics Minimum salary £2,000 per annum, with F S S U and children's allowances

Further particulars may be obtained from the Registrar, to whom applications (twelve copies), together with the names of three referees, should be submitted not later than February 28, 1955

APPOINTMENTS VACANT

WOOL INDUSTRIES RESEARCH ASSOCIATION

Physicists with honours degree required for (1) Fundamental research on adhesion, friction and abrasion (2) Weaving research The work involves experimental and analytical investigations on looms and in the laboratory , it requires mechanical aptitude and a liking for classical physics Age 22 to 26 Previous research experience not essential Commencing salary according to age and experience in range £530 to £845 per annum for post (1), and £530 to £665 per annum for post (2) , F S S U benefits

Applications to Wool Industries Research Association, Torridon Headingley Leeds 6

MEDICAL REPRESENTATIVES BRITISH subsidiary of leading American ethical pharmaceutical house have vacancies in several areas for Medical Representatives Good starting salary and expenses Car provided —Applications with full particulars of age, qualifications, experience and salary required in writing only, to the Manager, Pfizer, Ltd , 137-139 Sandgate Road Folkestone, Kent

GRADUATE CHEMIST, METALLURGIST or Chemical Engineer required, to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel —Apply Electro-Chemical Engineering Co , Ltd , 161 Queens Road Weybridge Surrey

SCIENTIFIC PERSONNEL OFFICER REQUIRED for Dunlop Research Centre near Birmingham, serving the Dunlop Group Chief duties will be the recruitment of graduate staff and the general working arrangements for research personnel Should already have experience in the selection of science graduates for industry possibly on a university appointments board, and accustomed to confer with professors and teaching staff of universities and technical colleges Would be required to exercise initiative in contacting managers to find out what staff is required, suggesting the types of people to be engaged, deciding where such people are most likely to be found and in finding them This is a high level appointment and salary will be appropriate to qualifications and experience —Applications should be made to Staff Training and Appointments Office, Dunlop Rubber Company Limited, Fort Dunlop, Erdington Birmingham 24

INDUSTRIAL STATISTICIAN QUALIFIED or experienced in industrial applications of statistics such as planning of experiments interpretation of data quality control of raw materials and finished products etc . This is a new appointment Salary £700 to £1 200 according to qualifications —Please apply for further particulars and application form to Chief Personnel Officer, J Bibby & Sons, Ltd , 57 Great Howard Street, Liverpool 3, quoting reference E 15 Applications will be treated in confidence

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

FUNDAMENTAL RESEARCH LABORAT
NUCLEAR PHYSICS AND GASEOU
DISCHARGE RESEARCH

Applications are invited for posts as Physi
for fundamental research in nuclear physics
in the physics of gaseous discharges Appli
should have a good honours or Ph D degree
preferably be under 28 years of age

Applicants should send full particulars, in
ing, to the Personnel Officer, Research Labora
Associated Electrical Industries, Limited,
maston Court, Aldermaston, Berks

THE B T H COMPANY HAVE
vacancy in their Research Laboratory
a Chemist or Physicist to engage in
preparation and processing of silicon
use as a crystal rectifier at ultra-high f
quency —Applicants should possess a deg
in physics or in chemistry and should wri
giving their age and other particulars to
Director of Research, British Thomso
Houston Co , Ltd , Rugby, quoting Ref
ence ATJ

PROFESSIONALLY QUALIFIED E
gineers and Physicists are required to
plore and develop new circuits based
transistors —Applicants should write to
Director of Research, British Thomso
Houston Co , Ltd , Rugby, quoting ref
ence BR and stating their age, qualific
tions and experience

THE B T H COMPANY HAV
vacancies in their research laboratory f
Assistants in the production, treatment a
processing of silicon in very pure for
Applicants should have some chemic
knowledge and preferably hold a nation
certificate in chemistry or physics —Th
should write, giving their age and other pa
ticulars to the Director of Research, Brit
Thomson-Houston Co , Ltd , Rugb
quoting reference ON

PHOTOGRAPHIC LABORATORY
ancy exists for experienced person (prefe
female), not over 35, to take charge of ro
work in photographic, spectrographic an
radiographic sections in Research Laborato
North London area Excellent working c
tions , responsible position , good salary in
cordance with experience —Apply by lette
Personnel Manager Ref P , Murex Welding
cesses, Ltd Waltham Cross, Herts

ORGANIC CHEMIST REQUIRED IN C
bridge to take part in Dr W E Ripper's
dealing with physiologically active compo
Salary according to age, qualifications, and
perience, but £600 per annum minimum —
(quoting No 996), with fullest particulars
salary required to Personnel Manager, F
Pest Control, Ltd , Bourn, Cambridge

SALES REPRESENTATIVE REQUIR
London office of chemical manufacturers to
London and Southern Counties Appli
should have chemical degree or training to
standard and be interested in sales side
23 to 30 Good salary Company's car
cellent prospects —Apply, with full partic
to Box 621, T G Scott and Son, Ltd , 14
Regent Street, London, W 1

CHEMISTS AND PHYSICISTS ARE
quired for a petroleum research station near
don Candidates should be aged 20 to 26
first- or second-class honours degrees, and sh
have fulfilled National Service obligations
vious industrial laboratory experience desir
but not essential Good working conditions
contributory pension scheme Salary accordi
age and qualifications —Write giving full de
and quoting H 3028 to Box 7191, c/o 191
ham House, E C 2

ANALYTICAL CHEMIST THE BRI
Drug Houses Ltd , Graham Street, London,
require an Analytical Chemist for work on
analysis of organic pharmaceutical compou
Candidates should be of B Sc standard Pre
experience desirable but not essential S
according to qualifications and experience
day week, canteen, sports club, pension and
sharing schemes —Write stating age, experi
if any, to the Staff Manager

MECHANICAL ENGINEER

VACANCY EXISTS AT ALUMINIUM ratories Limited, Banbury Oxon, for a nical engineering graduate interested in deformation research Preference will be to a graduate who has already had some ch experience in this field, and who has a ledge of current theoretical and experimental iques in plastic flow problems Initially, the sful applicant would be required to continue isting programme of research into the role ibricants in metal deformation processes would be opportunity for a suitable candi- to lead a section engaged in general metal mation researches within one or two years ssion of a higher degree would be an advan- in this latter connection —Applications full particulars of past training and experi- should be addressed in confidence to the tor of Research Aluminium Laboratories ed Banbury Oxon

RRANTI LIMITED EDINBURGH, RE- n graduate Physical Chemist to build up and charge of a small laboratory group and to in co-operation with development teams en- on the design of novel precision electrical mechanical equipment required by high ty government contracts The problems g from this work cover a wide field and de metallurgy properties of materials appli- ns of resins, lubricants anti-corrosion surfac- es etc , and there is full scope for initiative i expanding organization This is a senior ntment and candidates should preferably had several years industrial experience The will be commensurate with the responsi- s —Applications should be made to the nnel Department, Messrs Ferranti Ltd , e Toll Edinburgh 5, quoting reference .C

E BRITISH CERAMIC RESEARCH ciation has vacancies for honours graduates ysics or chemistry for work on a wide range roblems in the ceramic industry Previous rience in this field is not essential The ap- ments, which carry superannuation under U , are permanent and offer good prospects y will depend on age qualifications and ex- nce, but will be within the range £450 to for Scientific Officers, and £830 to £1,070 for r Scientific Officers —Applications together full details should be sent to the Director of rch Queens Road, Penkhull, Stoke-on- t

ADUATE CHEMIST OR ENGINEER RE- d by Research Association to apply in mem- factories results of research Position suit- young man recently qualified or some ex- nce Good starting salary excellent pros- , Pension scheme —Write particulars train- experience to Director British Launderers' rch Association The Laboratories, Hill View ens, Hendon N W 4

QUALIFIED CHEMIST IS DESIRED BY ll-known Yorkshire firm manufacturing surgi- plasters and dressings and pharmaceutical ucts The successful applicant will be re- d to take up the position of Principal Assis- to the Control Chemist in their Hull factory num second-class honours in chemistry or I C by examination necessary An interest nalytical techniques and physical testing is tial although the post is partly supervisory ous experience is desirable, though not essen- and the position is for a man below 30 years ge —Reply to Smith and Nephew Research Hunsdon Laboratories, Ware, Hertfordshire

IPRINOL LTD WISHES TO APPOINT A nical Sales Representative to forward the ntation of new fungicides Applicants d preferably possess a qualification in myco bacteriology or an allied science, and pre- experience in technical sales Technical sentatives with sales experience in manu- ring or processing industries, where con- tion has to be given to the possibility of l or bacteriological attack, may be con- d —Full details of qualifications and experi should be sent in the first place to Personnel ger Imperial Smelting Corporation, Ltd ndrew's Road Avonmouth, quoting Refe- CUL/N

IGINEER AGED 25 /35 WITH ELECTRI- r physicist degree required by Cable Com- in London area for development work on g equipment for telecommunication cables anent and pensionable position at salary nensurate with experience and qualifications ply, giving full particulars to Box 617, T G and Son, Ltd , 143-147 Regent Street lon, W 1

A PROFESSIONALLY QUALIFIED Engineer or Physicist is required for the development of electrical spark erosion methods as applied to the cutting of hard metals —Applicants should write to the Director of Research, British Thomson-Houston Co Ltd , Rugby, quoting reference BL, and stating their age, qualifications and experience

METALLURGICAL CHEMIST REQUIRED, for a large organization now situated in London but soon moving to Debden, near Loughton Essex Applicants should have experience in electro-deposition processes, modern testing and quality control techniques, and preferably some experience in a field of research The post would carry responsibilities for production by existing processes for technical developments, and for the replanning at the new factory which these developments would necessitate The appointment would be permanent and pensionable under a non-contributory scheme and facilities for house purchase would be made available if required —Candidates, who should be British by birth and under age 35, should write, stating age full details of education training and experience, to Box R 796 c/o Streets 110 Old Broad Street E C 2

REQUIRED, A QUALIFIED CHEMIST TO take charge of small Pharmaceutical Analytical Laboratory, preferably with experience in this work The laboratory is situated in Bristol Salary £600 to £700 according to experience and qualifications —Applications, giving full details to be sent to Box 616, T G Scott and Son, Ltd 143-147 Regent Street, London, W 1

REQUIRED, A QUALIFIED CHEMIST, TO take charge of small Pharmaceutical Analytical Laboratory preferably with experience in this work The laboratory is situated in Bristol Salary £600 to £700, according to experience and qualifications —Applications, giving full details, to be sent to Box 620, T G Scott and Son Ltd 143-147 Regent Street London W 1

BAKELITE LIMITED HAVE VACANCIES at their Aycliffe (Co Durham) works for two young qualified Chemists and a young Chemical Engineer Applicants should have a B Sc degree or equivalent, and some industrial experience The work concerns chemical and chemical engineering investigation into problems arising in the manufacture of P V C resins and compounds and the manufacture of products based upon P V C resins Salaries will be in the range of £650 to £850 per annum in accordance with age and experience —Applications should be addressed to the Personnel Manager Bakelite, Limited, 12 Hobart Place London S W 1

RESEARCH AND DEVELOPMENT Ferodo, Limited have vacancies for both Technical Assistants and graduate Technical Officers The Assistants should preferably have advanced level G C E in physics or chemistry, while some industrial experience, particularly of moulding or related technologies, would be advantageous The work is concerned with the development of various types of friction products and offers good opportunities for men with initiative and enthusiasm for the development of products in a new field Contributory pension scheme compulsory —Applications giving full details of age, education industrial experience, etc , and quoting T/RAD, to Personnel Manager Ferodo Limited Chapel en-le-Frith via Stockport

TECHNICAL SALES REPRESENTATIVE age 25 to 32 of good approach required by well known Company, to specialize in non-selective weed control products Knowledge of soils, weeds and mechanical appliances desirable Five-day working week —Apply in writing, stating qualifications and salary required, to Box 8253 c/o Charles Barker & Sons Ltd , 31 Budge Row London E C 4

APPLICATIONS ARE INVITED FROM RE-cently qualified male Chemists for interesting progressive post in cereal laboratory Work will involve non-routine analysis and research Applicants should be in 20 to 25 age group Five-day week and pension scheme in operation —Write, giving full particulars of academic qualifications and experience to Personnel Manager (L), Quaker Oats, Limited Bridge Road, Southall, Middlesex

WEST OF ENGLAND MANAGER RE-quired by dealers in chemical and scientific apparatus —Send full details of experience age and salary required to Box 615, T G Scott and Son, Ltd , 143-147 Regent Street, London W 1

TEXTILE CAREERS BRITISH NYLON Spinners, Limited have several vacancies for young graduates who will be given extensive technological training, enabling them to become specialists in this expanding organization The ideal qualification is a university degree in physics engineering or textiles, and candidates must have a natural bias towards applied work The selected candidates will be put to work under the supervision of experts, and training will include a thorough grounding in the manufacturing of yarns and fibres, and later in their development and processing to meet changing market requirements Upon successful completion of this training, it is intended to employ these graduates in responsible positions on either technical development and experimental work or in the field of technical service There will also be openings on the commercial side of the business, in which specialized knowledge can be applied to the development of new end-uses for the Company's products A realistic salary will be paid during training and these vacancies offer exceptional opportunities to men who are willing to work hard with a specific object and in a climate of technical stimulation and progress —Letters should contain full details of academic achievements and a frank statement of ambitions and inclinations, these should be addressed to the Personnel Manager, British Nylon Spinners Limited Pontypool and will be treated with strict confidence Candidates invited for interview will be given a very clear impression of all that is implied by this new type of career

THE ENGLISH ELECTRIC COMPANY IN-vites applications for progressive posts in the Mathematical Physics Group of the Guided Weapons Division Luton The work comprises theoretical analysis relating to a wide range of engineering problems and the application of electronic analogue and digital computers to their solution Applicants should hold at least an honours degree in mathematics, physics or engineering and should preferably have had several years' experience in engineering research The salary will be in accordance with qualifications and experience Assistance with housing accommodation may be given —Applications to Dept C P S 336-7 Strand, W C 2 quoting Ref S A 50B

SMITHS AIRCRAFT INSTRUMENTS LTD have vacancies in their Engine Controls Department for Senior and Junior Graduate Engineers and Physicists interested in research and development of automatic controls for aero gas turbines Experience in, and knowledge of theoretical and/or practical aspects of servo mechanisms, or magnetic amplifier and electronic techniques or electro-mechanical equipment, together with an appreciation of the requirements for airborne equipment, would be an advantage Salary would be commensurate with qualifications and experience —Apply giving details and qualifications, quoting Reference 49/EN to The Personnel Department, Smiths Aircraft Instruments Ltd , Bishop's Cleeve, near Cheltenham, Glos

BACTERIOLOGIST WITH UNIVERSITY degree, wanted to take charge of laboratory producing veterinary sera and vaccines Must be experienced in laboratory techniques and have had at least two years' practical experience Knowledge of veterinary work an advantage, but not essential —Box 619 T G Scott and Son, Ltd 143-147 Regent Street London W 1

A LARGE AND WELL-KNOWN CHEMI-cal Company invites applications for an important post as Works Manager of a modern chemical plant Applicants should be aged 38 to 45 and have a degree in chemistry or chemical engineering Considerable experience of management is essential and candidates should have the ability to apply modern management methods and to lead a production team A substantial salary will be paid Further details of the post, its location and the company's facilities will be given to those selected for interview —Applications which will be treated confidentially, should give full details of qualifications experience and present salary and should be addressed to Box 8252 c/o Charles Barker and Sons Ltd , 31 Budge Row London E C 4

ENGINEER AGED 22/35 REQUIRED BY Cable Company in London area for testing and maintenance of electronic equipment in new instruments for automatic testing of telecommunication cables —Apply giving full particulars to Box 618, T G Scott and Son, Ltd , 143-147 Regent Street London W 1

LADY CHEMIST GRADUATE OR H N C required for analysis of electroplating and allied solutions —Apply Electro-Chemical Engineering Co , Ltd , 161 Queens Road Weybridge Surrey

Advertisers please note You must add "Apply Employment Exchange" unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

THE SHELL PETROLEUM COMPANY, Limited, invites applications from Organic Chemists with a good honours degree, or equivalent, and preferably under 30 years of age, for post at their research centre, Thornton-le-Moors Cheshire The position entails maintaining close contact with the activities of the laboratories, and the progressing of patentable aspects of investigations in the petroleum lubricants and derived chemical fields Starting salary according to qualifications and experience, pension benefits —Write, giving full details of age qualifications, marital status, to the Shell Petroleum Company, Limited, Staff Department (R/T), St Helen's Court, London, E C 3

NUCLEAR PHYSICS SECTION OF A laboratory for long-term research The following appointments are available Research Physicist A good honours degree or Ph D in physics is required Applicants should preferably have a nuclear physics background or have some experience of research in this branch (and have fulfilled their obligations under the National Services Act) Research Assistant Applicants must have reached higher national or pass degree standard in electrical engineering or physics, and have had experience in electronics or with electrical or vacuum apparatus —Applicants should send full particulars in writing to the Personnel Officer, Research Laboratory, Associated Electrical Industries Limited, Aldermaston Court, Aldermaston, Berks

RESEARCH METALLURGIST REQUIRED to undertake investigations on metallurgical problems associated with the machining and cold forming of metals Candidates should possess a good degree The position is permanent and there are good prospects for advancement Superannuation scheme in operation —Send full details, including age experience, qualifications and salary required to Box 614, T G Scott and Son, Ltd , 143-147 Regent Street London W 1

WANTED A MAN TO TAKE CHARGE OF a new division on nuclear pile instrumentation The division is small at the moment but expected to expand considerably in the coming years and a very attractive career is offered to the right man Experiehce in servo systems and electronic circuitry is essential —Particulars, quoting reference R13, to the Personnel Officer, Ericsson Telephones Limited, Beeston, near Nottingham

ORGANIC RESEARCH CHEMIST REquired by company manufacturing fine and technical chemicals The work will be mainly on hydrogenation of aromatic compounds, with particular reference to stereochemistry of products Honours graduates preferred, some industrial research experience desirable Initial salary up to £850 The post can be regarded as permanent and pensionable —Apply, in writing, stating age and giving details of education and experience to Personnel Manager, Howards of Ilford, Ltd , Ilford, Essex

APPOINTMENTS WANTED

GOING TO SEED FIRST-CLASS M Sc , life experience asphalt and colouring matter trade, seeks humble clerical post in order to live Can't afford further advert —Box 622, T G Scott and Son, Ltd , 143-147 Regent Street London W 1

FOR SALE AND WANTED

FOR SALE, HILGER & WATTS' BIOCHEM Absorptiometer H 627 Constant Voltage Transformer (190-260 volts, 50 cycles), twelve Test Tubes, Filters £10 —Apply John Morrell & Co , Ltd , Bardney, Lincoln

FOR SALE OERTLING 48 ANALYTICAL Balance, Leitz Microscope and other equipment — A Bennett F R I C , 8 Brownlow Rd , Redhill

MISCELLANEOUS

ELECTRONICS APPLIED TO INDUSTRY Learn the basic principles and applications with our modern self-study course Experimental work included if required —Free Brochure from E M I Institutes, Dept N.56, London, W 4 (Associated with H M V)

GRANTS & SCHOLARSHIPS

NUFFIELD FOUNDATION

FELLOWSHIPS AND SCHOLARSHIPS IN DENTISTRY

The Nuffield Foundation invites applications from citizens of the United Kingdom, for Fellowships and Scholarships in Dentistry To help the advancement of teaching and research on dental health and disease, the Foundation is prepared to award a number of fellowships (i) to enable selected men and women with dental qualifications to receive such additional training in pure and applied science as is desirable to fit them for an academic career in dentistry (but not to obtain a medical qualification), and (ii) to enable selected university graduates in medicine and science to receive training that will qualify them to undertake teaching and fundamental research on dental health and disease The Foundation is also prepared to award a limited number of scholarships to assist students of outstanding ability attending a university dental school to devote one or two years to further studies of the basic sciences

Applications for fellowships should be received by March 1 annually and for scholarships by June 30 annually Copies of the conditions of both fellowships and scholarships and the application forms are obtainable from the Director, The Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N W 1

L FARRER-BROWN
Director of the Nuffield Foundation

NUFFIELD FOUNDATION

BIOLOGICAL SCHOLARSHIPS AND BURSARIES

The Nuffield Foundation, as part of its programe for the advancement of biological studies, is prepared to offer for the academic year 1955-6 a limited number of scholarships and bursaries to enable persons who have graduated in physics chemistry, mathematics or engineering, but who have had no training in a biological subject, to receive such training in biology as will enable them in due course to undertake research and teaching in the United Kingdom in the biological sciences The scholarships, which are senior awards, are intended for persons who have already undertaken some postgraduate research in their own subject The bursaries are intended to enable those who have recently graduated to complete a course of training in biological subjects, including, if considered necessary, a full honours degree course in biology In the case of both scholars and bursars the Foundation will pay the cost of university and/or college fees in addition to a maintenance award Graduates of universities in the United Kingdom, of either sex and preferably between the ages of 22 and 35, are eligible to apply

Applications for awards in 1955 must be received before April 1, 1955, by the Director, The Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N W 1, from whom further particulars and application forms can be obtained

L FARRER-BROWN,
Director of the Nuffield Foundation

FISHERIES RESEARCH STUDENTSHIP

The Secretary of State for the Colonies will award a Fisheries Research Studentship with a view to fitting the holder for fisheries research work in the Federation of Malaya as a member of the Research Branch of Her Majesty's Oversea Civil Service The work will involve study of the digestive enzymes of cultivated fish, with a view to securing the best use of natural and added foods in tropical fishponds, and chemical and biochemical analyses of the pond water, mud, plankton and fish, aiming at an increase in the efficiency of fish farming The Studentship will be tenable at a United Kingdom University, for twelve months in the first instance The holder will be required to undertake to serve subsequently for at least three years overseas Minimum academic qualification a good second-class honours degree in biochemistry, physiology, zoology or botany The value of the Studentship is between £25 and £34 10s a month, tax free according to the location of training with additional allowances for married candidates Tuition fees and certain other expenses will be paid in addition Applications are invited both from persons already possessing the required degree and from those who expect to qualify in 1955

Applications to the Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting reference BCD 418/324/01

THE ROYAL SOCIETY

RUTHERFORD SCHOLARSHIP

Applications are invited from graduates
university within the British Commonwealt
are under 26 years of age on October 1,
for the Rutherford Scholarship This w
awarded for research in any branch of the
sciences, but some preference will be giv
favour of candidates who propose to work
perimental physics It will be tenable for
years in some part of the British Common
other than that in which the applicant grad
The value of the scholarship will be adjus
meet the circumstances of the appointment
held in the United Kingdom it will be n
than £450 per annum Additional allo
may be granted for travel, university fee
The appointment will date from October 1,
The appointment will be made by the Pr
and Council of the Royal Society

Application from university graduates
the United Kingdom should be made t
their universities to the Royal Commission f
Exhibition of 1851, on forms of applicati
the 1851 Exhibition Science Research Schol
Application from university graduates
United Kingdom should be made before Fe
15 1955, on forms obtainable from the As
Secretary, Royal Society, Burlington
London W 1

UNIVERSITY OF DURHAM

KING'S COLLEGE NEWCASTLE UP TYNE

GEORGE ANGUS STUDENTSHIP

Applications are invited for the above
tioned Studentship, of the value of £35
annum, which is available annually for post
ate research in the Department of either C
try, Physics or Mechanical Engineering as a
of a gift from Messrs George Angus and
Ltd , of Newcastle upon Tyne The St
ship is open to graduates of approved unive
or the holders of approved qualifications
tenable for two years, but may be renewed
third year in special circumstances

Forms of application and further part
may be obtained from the undersigned, to
completed application forms must be return
January 31, 1955

G R HANSON,
Registrar of King's Coll

NUFFIELD FOUNDATION

SOCIOLOGICAL SCHOLARSHIPS AN BURSARIES

The Nuffield Foundation, in pursuance
programme for the advancement of sociol
studies, is prepared to offer for the academi
1955-6 a small number of scholarships and
saries to enable graduates in academic su
other than the social sciences, psychology or
omics, to study the social sciences The Fo
tion's particular object is to enable me
women, who are already well qualified in
disciplines, particularly the natural sciences
humanities, to receive a training in for exa
political science, social psychology, anthrop
social statistics and sociology generally (bu
economics) so that in due course they may
take research or teaching in the United Ki
in those subjects The scholarships, whic
the senior awards, are intended for person
have already undertaken some postgraduate
in their own subject The bursaries are int
to enable those who have recently graduat
take a course of training in sociological su
In the case of both scholars and bursar
Foundation will pay the cost of university a
college fees in addition to a maintenance a
Graduates of universities in the United Kin
of either sex and preferably between the ag
22 and 35, are eligible to apply

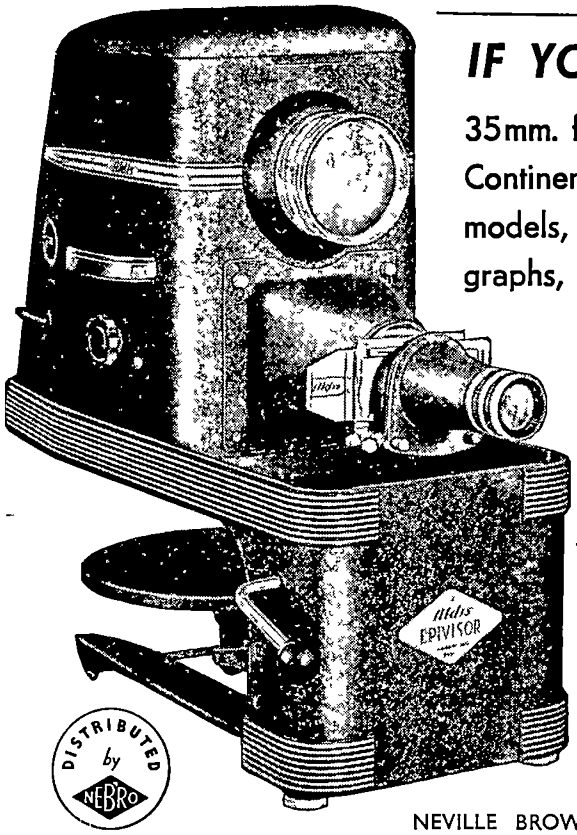
Applications for awards in 1955 must b
ceived before May 1, 1955, by the Director,
Nuffield Foundation, Nuffield Lodge, Re
Park, London, N W 1, from whom full parti
and application forms can be obtained

L FARRER-BROW
Director of the Nuffield Found

BEIT FELLOWSHIPS FOR SCIENTIFIC RESEARCH

Notice is hereby given that the Thirty-se
Election of Fellows will take place on or
July 7, 1955 At present one Fellowship is
able each year Applications must be receive
or before March 1, 1955, and candidates mu
under the age of 25 on the date of electio

Forms of application and all information
be obtained by letter addressed to the Reg
Imperial College, South Kensington, Lo
S W 7



IF YOU WANT TO PROJECT

35mm. film strips, 2"x2" or 3¼"x3¼" slides, Continental slides, micro slides, specimens, models, drawings, blueprints, photographs, graphs, etc., etc....

THERE IS ONLY ONE ANSWER

Aldis

'EPIVISOR'

(Registered Trade Mark)

EPIDIASCOPE

This versatile instrument enables you to project greatly enlarged and perfectly defined images of flat and solid objects, as well as film strips and slides It is indispensable in research and in training Full details will gladly be sent on request, together with the name of your nearest dealer, who will be pleased to demonstrate

Sole Wholesale Distributors.
NEVILLE BROWN & CO LTD, 77 NEWMAN ST, LONDON, W I

NIPA-ESTERS

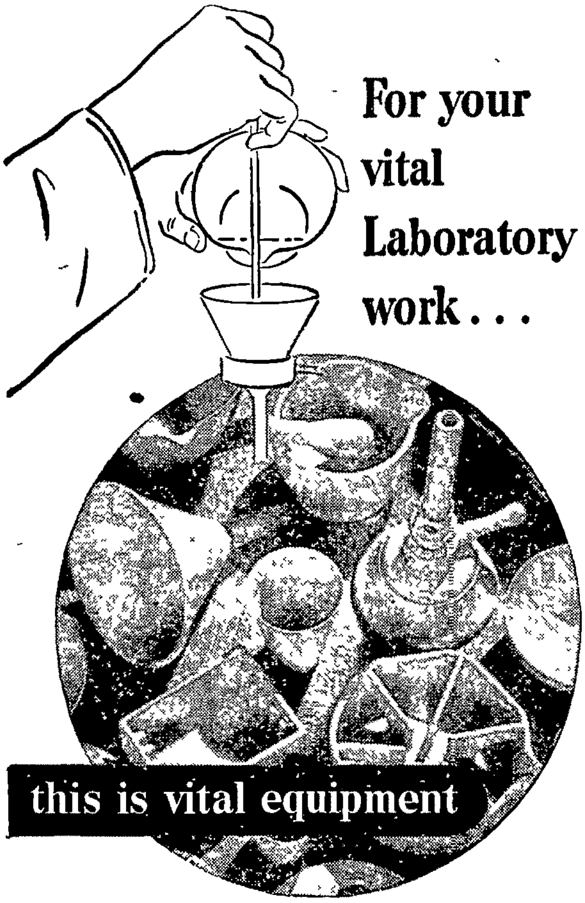
PARAHYDROXYBENZOATES GALLATES

The well-known & reliable neutral preservatives, antiseptics, antioxidants for all scientific and industrial purposes

NIPAGIN
NIPASOL
NIPACOMBIN
NIPABENZYL
PROGALLIN
PHENOXETOL

NIPA LABORATORIES LTD., TREFOREST TRADING ESTATE, Near CARDIFF
Telephone: Treforest 2128/9

Sole Distributors for the U K
. SAMUELSON & CO, ROMAN WALL HOUSE, 1, CRUTCHED FRIARS, LONDON, E.C.3 *Tel Royal* 2117/8



For your vital Laboratory work . . .

Special hard porcelain for chemical and scientific use has been produced by Royal Doulton for over 30 years It combines the following advantages

- Excellent resistance to high temperatures and to thermal shock caused by temperature fluctuations
- The glaze, which is perfectly married to the body of the ware, withstands the strain of heating up and cooling down
- The use of first quality raw materials gives the finished product high resistance to chemical attack
- The raw materials are carefully selected to ensure freedom from iron contamination.
- High mechanical strength is apparent even in the thin-walled articles normally used in laboratory practice

Write for further details to Doulton & Co. Limited, Industrial Ceramics Division, Dept. C, Doulton House, Albert Embankment, London, S.E 1.

Royal
DOULTON
LABORATORY PORCELAIN

LP19R

The Hall-mark of a PRIOR *Precision-built Microscop*

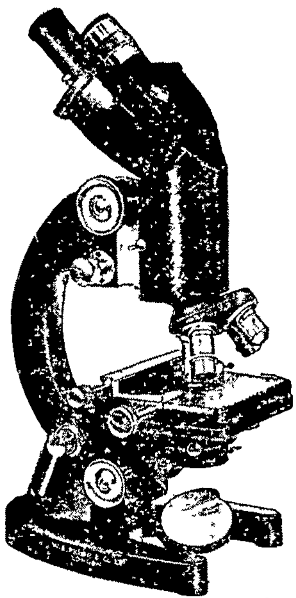
THE
PRIOR
"UNIVERSAL"
BINOCULAR
MICROSCOPE
A precision instrument
made by Specialists
for Specialists

*

Available with Vertic
Binocular and Monocul
Bodies
Flat Top or Circular r
tating mechanical stag
Standard Objectives an
Eyepieces of all power

*

Details on Request



W. R. PRIOR & CO. LTD.
NORTHGATE END BISHOP'S STORTFOR
HERTFORDSHIRE

CATHODE RAY POLAROGRAPH

For Accurate and Speedy Analysis

METALLURGICAL **INORGANIC**

ORGANIC

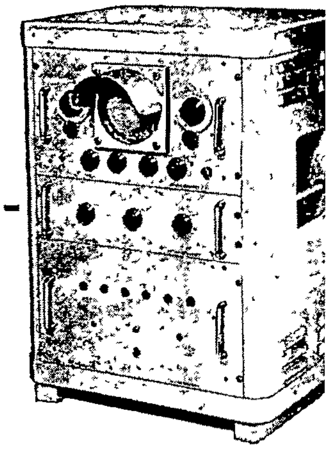
BIOCHEMICAL

QUALITATIVE

QUANTITATIVE

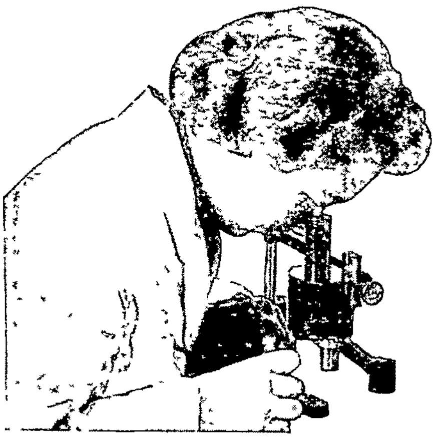
ROUTINE • SPECIAL RESEARCH

Write for leaflets
SOUTHERN INSTRUMENTS LT
Special Products Division
CAMBERLEY • SURREY *Phone: Camberley* 2



FOR TEACHING

FOR INDUSTRY

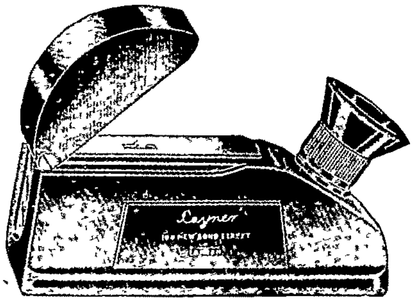


ERECT IMAGE
DISSECTION & INSPECTION
MICROSCOPE

Features include clear working space under objective and optional self-contained spotlight using sub miniature bulb mounted under prism box

Longworth
SCIENTIFIC INSTRUMENT CO LTD
ABINGDON, BERKS

RAYNER
REFRACTOMETER

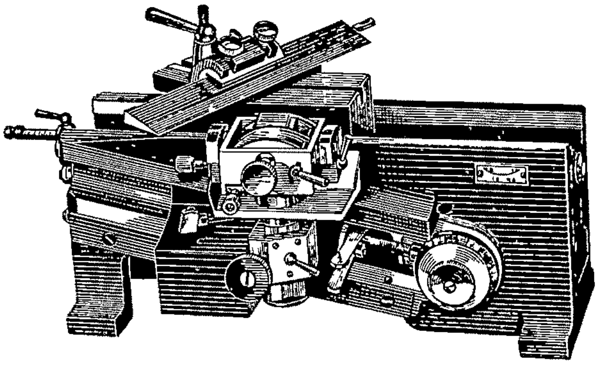


Price: In case with 1·81 fluid, yellow filter and polarizing filter, £15 16s

Scale 1·30–1·86 in intervals of 0·01 Estimation to 0·001 in white light with filter. Designed for mineralogy, gemmology, routine checks for transparent solids, and for much work with fluids

RAYNER
100 NEW BOND STREET, LONDON, W.1
Telephone GRO 5081

REICHERT
MICROTOMES



for

SECTION PERFECTION

The **Reichert OME Sliding Microtome,** shown above, is undoubtedly the best all-round instrument available It will cut equally well paraffin, celloidin, and frozen specimens, and experience has shown again and again that this instrument is capable of solving the toughest and most difficult sectioning problems The **OME** microtome incorporates fully automatic feed from 1 to 30 microns, universally adjustable knife clamp to take knives between 160 and 240 mm length and the invaluable Naples object clamp for precise block location

The **Freezing Microtome OMP** is remarkable for the design of its knife carrier which permits correct cutting angle adjustment and is permanently supported by the knife track Equally well known is the **Rotary Microtome OMS** with Automatic Ribbon Conveyor

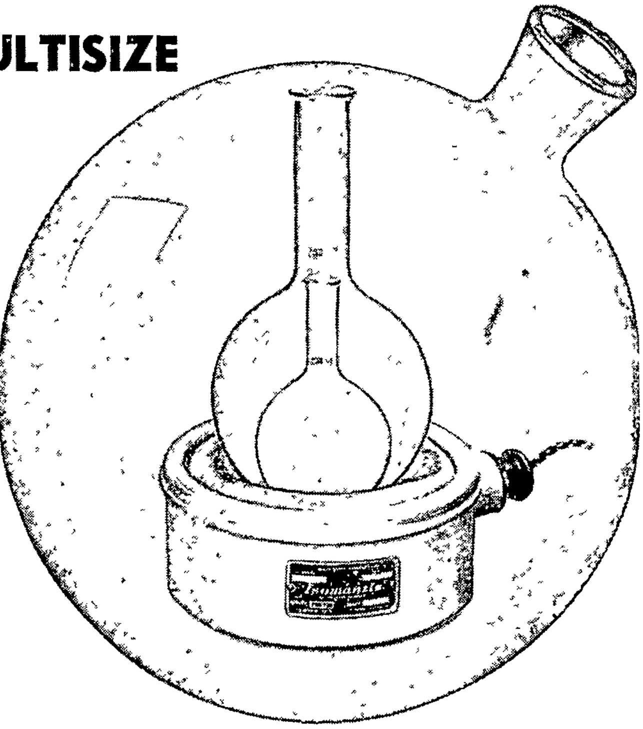
We keep comprehensive stocks of superior quality microtome knives, hand-made for us in Heidelberg by people who have specialized in this field for many decades

SHANDON

SHANDON SCIENTIFIC COMPANY LTD.
6, CROMWELL PLACE, LONDON, S.W.7 Tel: KNI 1131

Isomantle
REGD. TRADE MARK

MULTISIZE



A New Type has been added to the popular Multisize range:

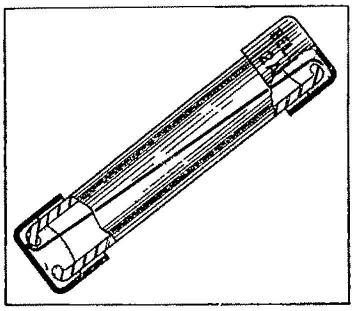
MUL/1/E for flasks from 100 ml to 1 litre, 250W The element of this Mantle covers only the lower part of the flask, so that the contents can be observed whatever the flask size, thus it is particularly suitable for educational purposes, and costs only **£4 . 10 . 0**

This is one of the many types of electric Heating Mantles described in Catalogue LM, which we shall gladly send on request, for Plant Mantles see Catalogue PLT.

Isomantles are built to last, they are simple to run, efficient and of neat appearance.

Isopad Ltd., 30-32, Rosemont Road, London, N.W.
Telephone HAMpstead 8466/7

COMPONENTS FOR THE LABORATORY



FUSE-LINKS OF REAL PRECISION (B.S. 646 (B))

The L1055 is available in ratings from 60 mA to 25 A, but at present this **new construction* applies only to ratings of 500 mA and over It is hoped to include the lower ratings later, but in the meantime, industry will be supplied with our original design in which we have always minimized the problems that "all-in-one" construction obviates

**** Caps that come loose are things of the past They are now locked to the glass by a unique internal soldering technique, which bonds caps, filament and glass into one unit. The glass has to break before the caps will move, and as caps are coded, the risk of replacement by wrong ratings is obviated Mechanically and electrically this is a better fuse-link.***

Please write for catalogue P 347/NA. for details of full range

BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE
FROM LIVER OR YEAST
and other SIGMA brand products are now available
Ask for list SIGMA 8
GEORGE T. GURR LTD.
136-138 NEW KINGS RD, LONDON, S W 6
The Microscopical Stain People

• Individually Tested and Guaranteed •
(A E R E Harwell approved)
HIGH VACUUM STOPCOCKS
New Catalogue on request to
G. SPRINGHAM & CO. Harlow New Town
"The Stopcock People" HARLOW 24108

TECHNICAL PHOTOGRAPHY

SIMPL LTD. undertakes all branches of scientifi photography in monochrome and in colour Fluorescenc photography and by infra-red and ultra-violet radiation

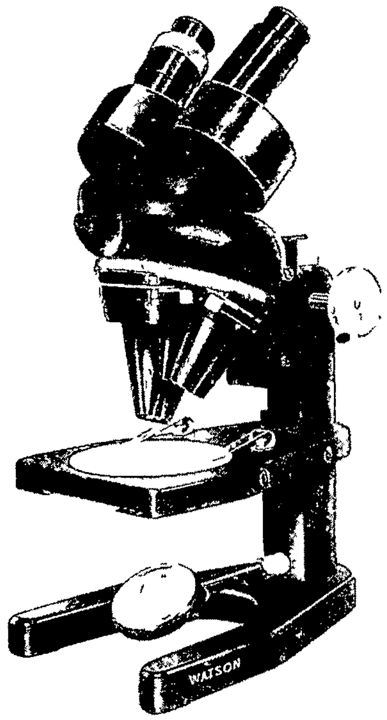
SIMPL LIMITED, 1-4 LAMBETH HIGH ST, LONDON, S E

• SPECIFIC IMMUNE SERA
ANTI BEEF, CAT, CHICKEN, DEER, DOG, HORSE HUMAN, PORK, RABBIT, SHEEP
(OTHERS ON REQUEST)
$12.50 per 5 cc Identifications performed Write for detail
Wisconsin Alumni Research Foundation
506 N WALNUT STREET MADISON 5 WIS., U S A

Watson Stereoscopic Microscopes will satisfy the most fastidious user

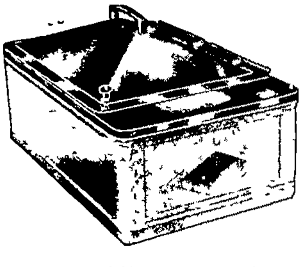
They are available in a wide range of stands and can be fitted with a variety of optics Offering, as they do, a true stereoscopic image, they can be applied to any problem where the three dimensions, length, breadth and depth, are to be investigated The illustration is of the "Research" model Write for List 6B

WATSON'S



W. WATSON & SONS LTD. 313 HIGH HOLBORN, LONDON, W.C.1

LTE **Universal Water Bath**



These L T E Baths are designed to have the widest range of applications and are available in four sizes Temperature ranges from room temperature or slightly below, using the cooling unit, to 100° C Deviation from the desired mean temperature is within 0 5° C Sensitive temperature control ensures adequate performance under all conditions Racks and fittings are available for all the standard tests and "Custom Built" racks and fittings are made to specifications

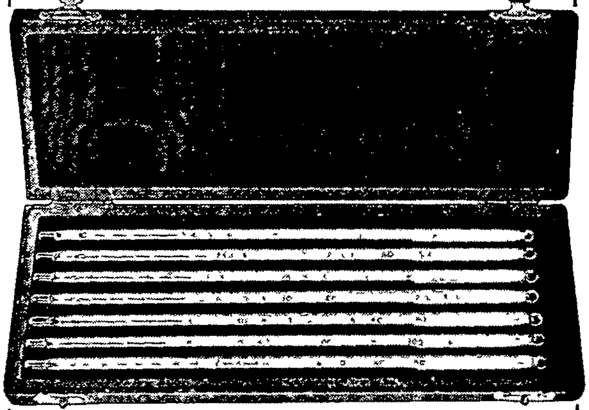
You can prove the efficiency of L T E equipment before you order all standard models can be supplied on one month's approval without obligation and every standard L T E product is backed by a two-year guarantee

ustrated Catalogue on request to

ABORATORY THERMAL EQUIPMENT LTD

GREENFIELD, Nr OLDHAM, ENGLAND
Telephone Saddleworth 552

Thermometers . . .
hydrometers . . .
SCIENTIFIC INSTRUMENTS
Made to I.P., B S S , S T.C.P.T. & A.S.T M specifications N P L. Certificates if required



Set of Short Range, Short Stem thermometers made to B.S 1365 1951 In morocco leather case

Phone
Liberty
2283-6

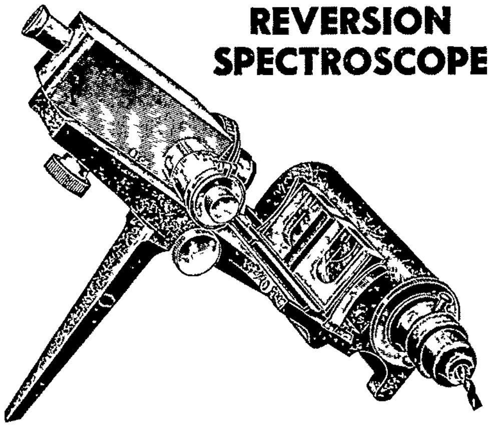
EST. ZECOL 1888

Telegrams
Zealdom,
Souphone,
London

G. H. ZEAL LTD.
LOMBARD RD , MERTON, LONDON, S W 19

BECK HARTRIDGE

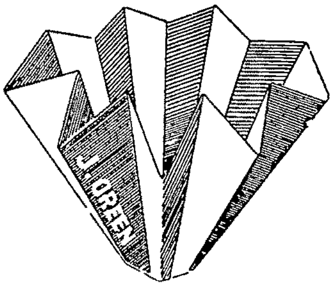
REVERSION SPECTROSCOPE



For all spectrometric work, absorption or emission, the reversion method gives the most accurate results. Readings can be obtained to an accuracy of I Å.

Full particulars forwarded on application

R. & J. BECK LTD., 69 Mortimer St., LONDON, W.1



GREEN'S PURE FILTER PAPER

This is our "simple fold". The price is lower and it saves shipping space for export

See price list NG

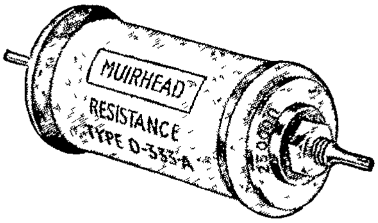
J. BARCHAM GREEN LTD.
Maidstone • England

All Square

The squared grid Eyepiece Graticule makes high demands on line quality Too thick and you have a prison window, too fine and it will swim out of sight. Hence our range of squared graticules is extensive, to cover all requirements Made in four sizes—¼ mm, ½ mm, 1 mm and 2 mm squares, in five different patterns—on a field of 10 mm. diameter, in a square of 100 squares numbered and lettered, over the whole field, with every tenth line thickened, or in chessboard with alternate clear and grey transparent squares All priced at 19s. each, on 21 mm. discs.

Full list of Eyepiece and Stage Micrometers from

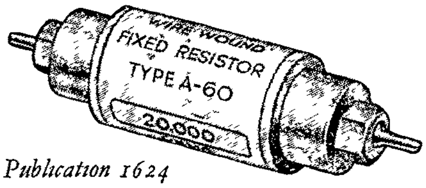
Graticules
LIMITED
57–60, HOLBORN VIADUCT, LONDON, E
Phone CENtral 2717/8 Grams Rheinberg, Cent, Lon



PRECISION RESISTORS

for

VITAL CIRCUITS



115

Write for Publication 1624

MUIRHEAD & CO. LTD
PRECISION ELECTRICAL INSTRUMENT MAKERS
BECKENHAM KENT ENGLAND
Telephone BECKENHAM 0041
Telegrams & Cables MUIRHEAD, BECKENHAM

PRECISION MUIRHEAD ELECTRICAL INSTRUMENT

Printed in Great Britain by FISHER, KNIGHT & Co, LTD, The Gainsborough Press, St Albans, and published by MACMILLAN & Co, LIMITED, at St Martin's Street, London, W C 2, and ST MARTIN'S PRESS, INC, 103 Park Avenue, New York 17, N Y, U S A —Saturday, January 15, 1955

NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

INSTITUTE OF RADIO PHYSICS AND ELECTRONICS
LIBRARY
Date 28

VOL 175, No 4447 SATURDAY, JANUARY 22, 1955 TWO SHILLINGS

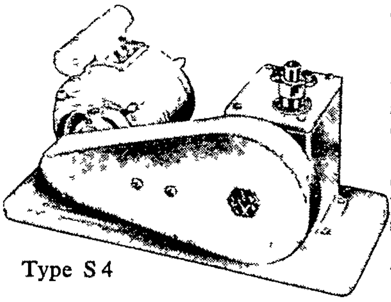
PHASE CONTRAST OUTFITS

- For excellent performance at modest cost
- Fit Baker or other microscopes made to accepted standards
- Available in powers ×10, ×40, ×100
- Outfits from £28 10s
- Complete instruments from £62 4s

C. Baker
OF HOLBORN LTD. EST. 1765

METRON WORKS, PURLEY WAY
CROYDON, SURREY - (CROydon 6644)
London Showrooms 244 High Holborn, W.C.1

METROVAC PUMPS



Type S 4

Typical of the Metrovac range of rotary pumps, the Type S 4 has a displacement of 0 4 litres/sec

Other models cover the range up to 33 litres/sec

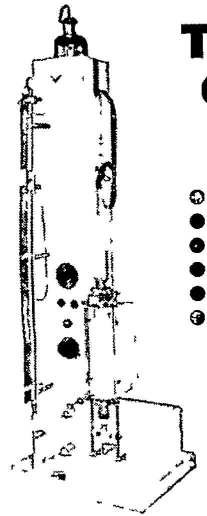
Please write for full details

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

Member of the A E I group of companies

VACUUM PUMPS

N/P402



THE NEW B.T.L. VAN SLYKE GAS ANALYSIS APPARATUS

The Van Slyke Standard Manometric gas analysis apparatus has been completely redesigned to conform to modern practice and the following features are of particular interest

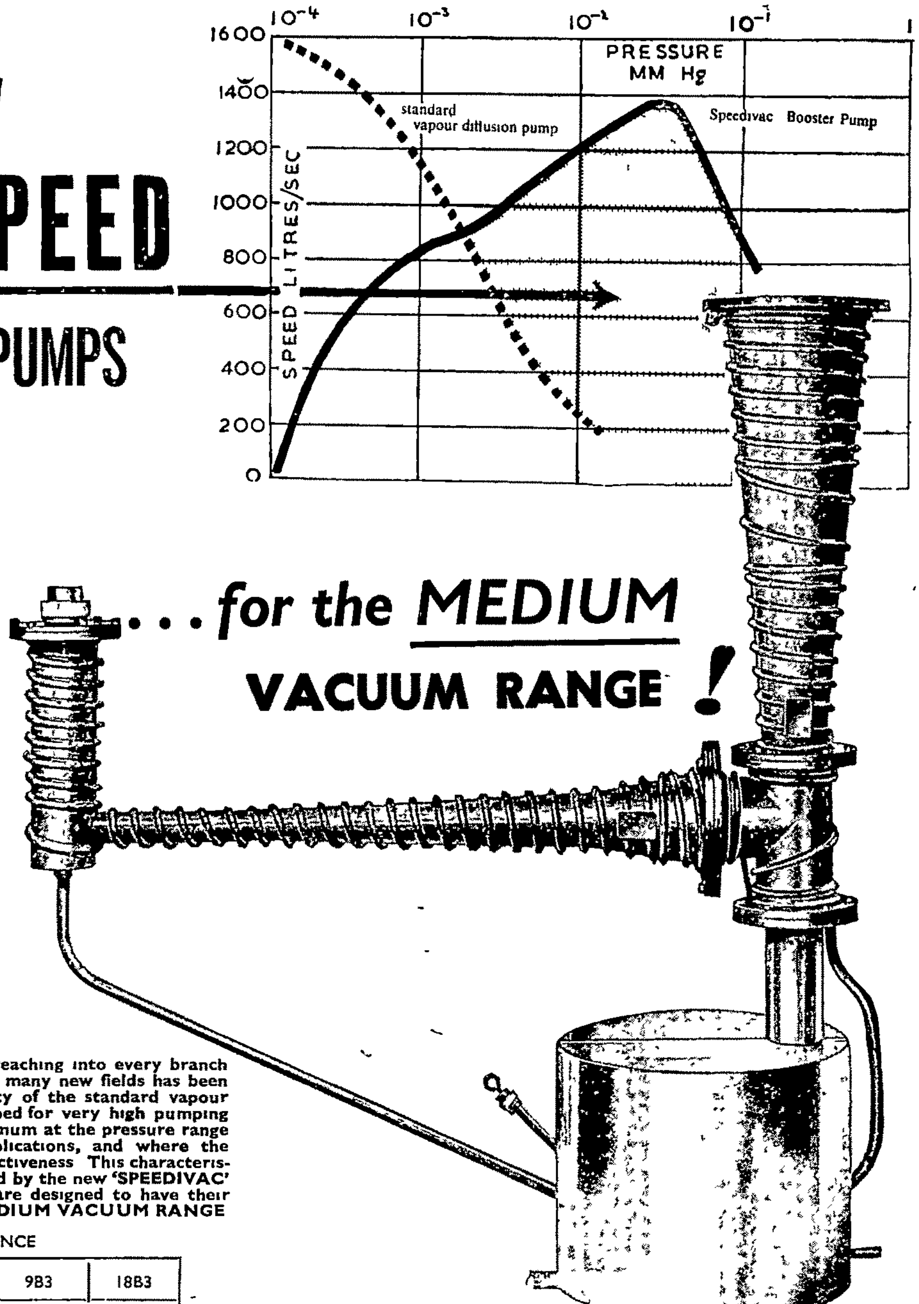
- Glass water jacket is illuminated to give a clear view of the shaking pipette
- Manometer fitted with illuminated meniscus-reader for accurate readings
- Easy adjustment of manometer and connecting tubes
- Totally enclosed motor and drive mechanism
- Rotary rheostat for control of shaking speed from a maximum of 200 per minute
- Timer and alarm buzzer can be fitted as an extra

Price £60 or with timer £70. Immediate Delivery. Full details will be sent on request

BAIRD & TATLOCK
(LONDON) LTD.
Scientific Instrument Makers
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

BTL
Member of
SCIEX

NEW
HIGH SPEED
VAPOUR PUMPS



. . . for the MEDIUM VACUUM RANGE!

High vacuum technique is reaching into every branch of industry, but progress in many new fields has been impeded by the unsuitability of the standard vapour pump, which, though developed for very high pumping speeds, is far from its maximum at the pressure range important to the new applications, and where the rotary pump is losing its effectiveness. This characteristic speed 'GAP' is now closed by the new **'SPEEDIVAC' BOOSTER PUMPS** which are designed to have their maximum speeds in the **MEDIUM VACUUM RANGE**

PERFORMANCE

	9B1	9B3	18B3
ULT VAC mm Hg	BETTER THAN 10^{-4}		
Peak speed lit./sec unbaffled	40 at 1·85 kW	850 at 2·25 kW	1300 at 6·4 kW
Recommended backing pump displacement, lit./min	450	450	2800
Recommended backing pump	1SC450	1SC450	1SC3000

Other Valuable Features

- ★ *De-gassing Vacuum Furnaces Metallurgical and chemical processes Vacuum stills Impregnation*
- ★ *Backing pressure performance enables gas flow to be handled by smaller backing pump and lines*
- ★ *Economical operation compared with alternative evacuation methods*
- ★ *The new booster pumps backed by a 'Speedivac' gas-ballast rotary pump maintains a very high exhaust rate at critical pressures for contaminating process vapours*

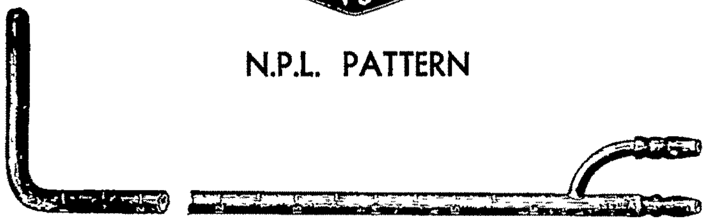
W. EDWARDS
& CO (LONDON) LTD
MANOR ROYAL CRAWLEY SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

for better vacuum service

BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

PITOT CASELLA LONDON **TUBES**

N.P.L. PATTERN



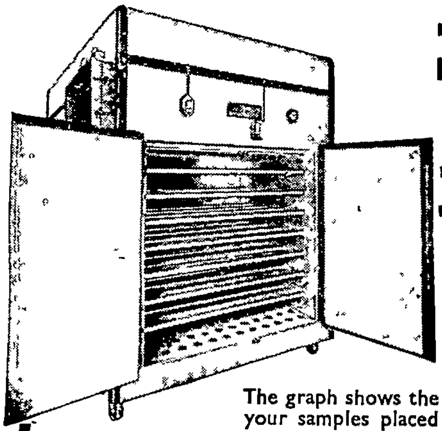
Combined Pitot and Static Tube, in brass

STOCK SIZES:
18 in (46 cm), 24 in. (61 cm.), 36 in (92 cm.), 48 in. (122 cm.), 60 in. (152 cm.)
divided in inches or centimetres

Other sizes to special order

C. F. CASELLA & CO. LTD.
Regent House, Fitzroy Square, London, W.1
Telephone ★EUSton 3944

Member Scientific Instrument Manufacturers' Association of Great Britain



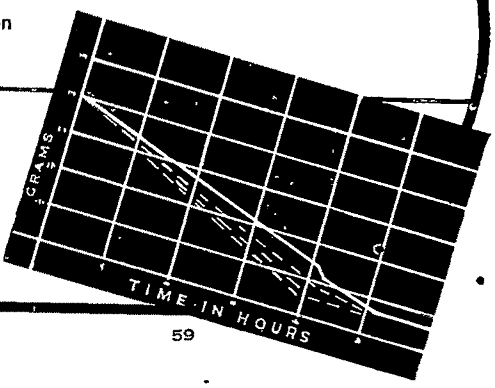
LABORATORY TESTED & APPROVED

The UNITHERM DRIER has been carefully tested under working conditions, and is now being used in Laboratories and Grassland Research Stations all over the world, to provide rapid Uniform Drying at temperatures controlled within ± 2° C up to 110° from 40° C

The graph shows the uniform rate of drying of your samples placed in different parts of the oven

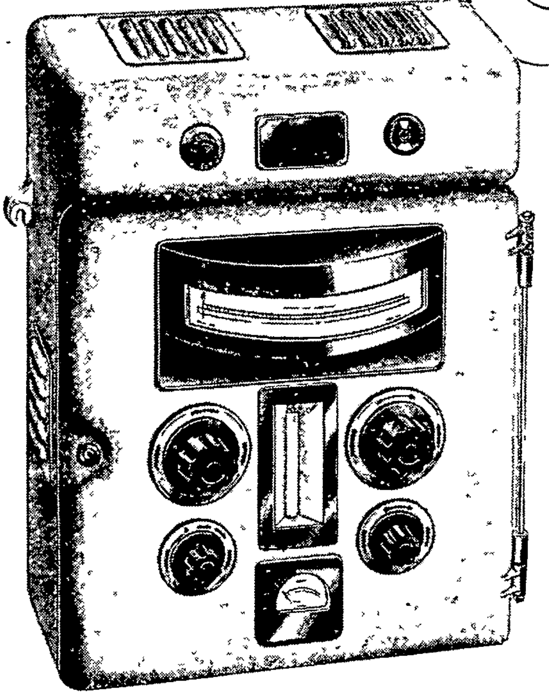
Full details will be gladly sent to you upon request

BIRMINGHAM & BLACKBURN CONSTRUCTION CO. LTD.
ARMOURY CLOSE, BORDESLEY GREEN,
BIRMINGHAM, 9
AND HARLEY STREET. BLACKBURN.



BAKER PLATINUM

deoxo Indicator



FOR THE DETECTION AND CONTINUOUS MEASUREMENT OF TRACES OF OXYGEN AND HYDROGEN IN GASES

During recent years many industries have sought a practical and accurate means for detecting and measuring small quantities of oxygen present as an impurity in other gases. The Deoxo Indicator has been designed to supply this need. Ruggedly constructed and capable of operation for long periods with little or no attention, the instrument is suited both to industrial and to laboratory use. It indicates the presence of from .001% to 1% oxygen in inert gases, hydrogen, nitrogen, carbon dioxide and saturated hydrocarbon gases. The accuracy of indication is conservatively estimated at ±2% of the value of full scale reading

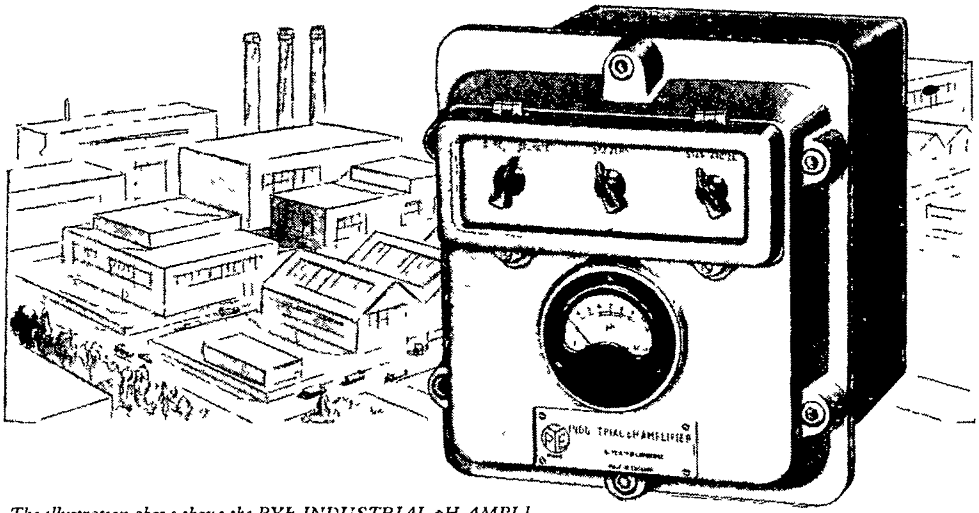
The Deoxo Indicator may be used to detect and measure hydrogen (instead of oxygen) impurity in inert gases, nitrogen, carbon dioxide and saturated hydrocarbon gases.

★ *A copy of the illustrated leaflet giving full details of the Deoxo Indicator will be forwarded on request. Technical representatives are always available for consultation and advice*

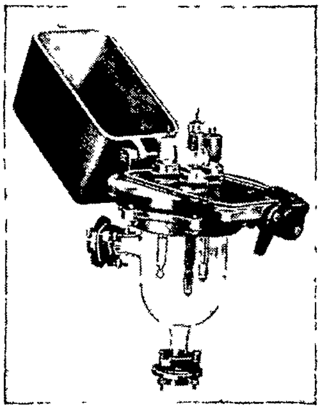
BAKER PLATINUM LTD. 52 HIGH HOLBORN, LONDON, W C 1. *CHAncery* 8711

Originators of the 'Deoxo' process for catalytic gas purification

PYE INDUSTRIAL pH AMPLIFIER



The illustration above shows the PYE INDUSTRIAL pH AMPLIFIER Cat No 11400, which is built into a flame-proof case, constructed for easy servicing and designed for the continuous measurement of pH values It will drive controllers, recorders, remote indicators and alarm-relays Below on the left is illustrated the Continuous Flow Electrode Assembly, Cat No 11420 and on the right the Immersion Type Electrode Assembly, Cat No 11405 May we send you details of these instruments?



IN every industry where water or chemical solutions are used, money can be saved and efficiency can be increased through effective pH measurement and control The exact measurement of acidity and alkalinity will readily provide the key for methods of eliminating waste, reducing maintenance and corrosion, developing new products and improving product quality at the lowest possible cost

The glass electrode pH Amplifier operated from the mains, and presenting a direct indication, provides the simplest, quickest and most efficient method of measuring and controlling pH The use of this type of instrument is quickly becoming a major feature of the current trend towards instrumentation in industry

SCIENTIFIC PYE INSTRUMENTS

W G PYE & CO LTD., GRANTA WORKS, CAMBRIDGE

W G52

"Spectrosol"

Hopkin and Williams Ltd. are now in a position to supply the following solvents in the " Spectrosol " range. These solvents are specially purified for absorption spectroscopy and are supplied only by Hopkin and Williams Ltd.

CODE NO.	
2858.5	**Carbon Tetrachloride**
3073	**Chloroform**
3566.3	**Cyclohexane**
4118.5	**Ethyl Alcohol**

A signed analytical certificate indicating the spectroscopic purity of the contents is supplied with each container

The rapidly increasing use of quartz spectrophotometers in all types of industrial and research laboratories has created a correspondingly increased demand for solvents of adequate ultra-violet transparency, and it is in this branch of the spectroscopic field that "Spectrosol" solvents will find their main application. Further additions to this range of solvents will be announced from time to time as they become available. A leaflet describing the present range of " Spectrosol " solvents is available on request.

" Spectrosol " Solvents
are available only from
Hopkin & Williams Ltd.

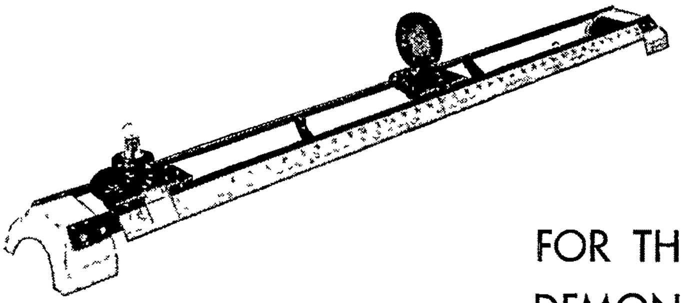
HOPKIN & WILLIAMS LTD

Manufacturers of pure chemicals for Research and Analysis

FRESHWATER ROAD CHADWELL HEATH ESSEX

THE EEL

OPTICAL BENCH



FOR THE QUANTITATIVE
DEMONSTRATION OF
OPTICAL LAWS

This apparatus can be supplied complete with micro-ammeter and voltage stabilizing transformer. A free booklet issued with the equipment describes in detail the following ten preliminary experiments :—

1 Proportionality of cell output
2 Polar curve of lamp
3 Lamp characteristic
4 Variation in cell response with angular rotation
5 Variation in light intensity with distance from point source
6 Comparison of lamp candlepower
7 Illumination at a point on a large plane surface
8 Measurement of transmission factors and optical density
9 Photocell sensitivity
10 Photocell characteristics

Full details of this and other "EEL" photoelectric apparatus readily available on application

SELENIUM PHOTOCELLS
NEPHELOMETERS
PHOTOMETERS
DENSITOMETERS
ABSORPTIOMETERS

EVANS ELECTROSELENIUM LTD

Sales Division 25 HARLOW ESSEX

ELECTROPHORESIS APPARATUS
OPACIMETERS
SPECTROPHOTOMETERS
REFLECTOMETERS
etc , etc

Representatives for sales and service

Manchester area —Messrs A M Lock & Co , Ltd , Crompton Street, Chadderton, Oldham, Lancs

North of England —Messrs Electricals, Ltd , 14 Claremont Place, Newcastle-upon-Tyne, 2

Scotland —Messrs Atkins Robertson & Whiteford, Ltd , 92–100 Torrisdale Street, Glasgow, S 2

Tracer Compounds for Chemical & Biological Research

Some recent additions to our C.14 list:—

Margaric acid-1-C14
Glyceryl tri (stearate-1-C14) (Tristearin)
Glyceryl tri (palmitate-1-C14) (Tripalmitin)
Glyceryl tri (stearate-2-C14) (Tristearin)
Succinic acid-1-C14
Fumaric acid-1-C14
Maleic anhydride-1-C14
Phenyl (acetic acid-1-C14)
Cetyl alcohol-1-C14
Aniline hydrochloride (generally labelled)
D-Glucose-1-C14
D-Glucono-*delta*-lactone-1-C14
D-Mannose-1-C14
Carbon (elementary)
Sodium *iso*-caproate-1-C14
DL-Leucine-1-C14
Sodium pyruvate-2-C14
Sodium pyruvate-3-C14

•

We can now supply more than one hundred compounds of carbon-14.

•

For further information write to.

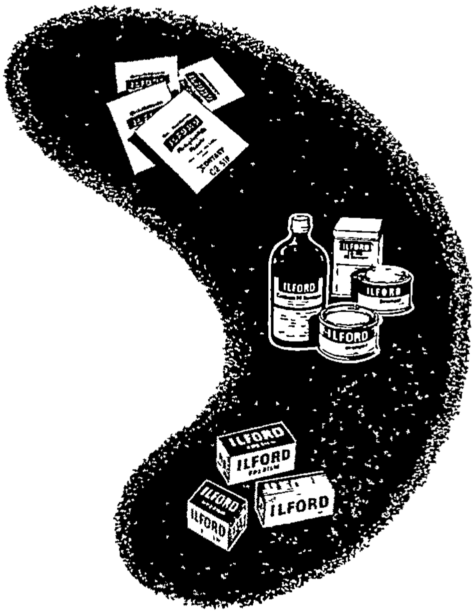
THE RADIOCHEMICAL CENTRE, AMERSHAM, BUCKINGHAMSHIRE,
ENGLAND

These products are distributed in U.S.A. by the Nuclear Instrument and Chemical Corporation of Chicago

TAS/RC 8

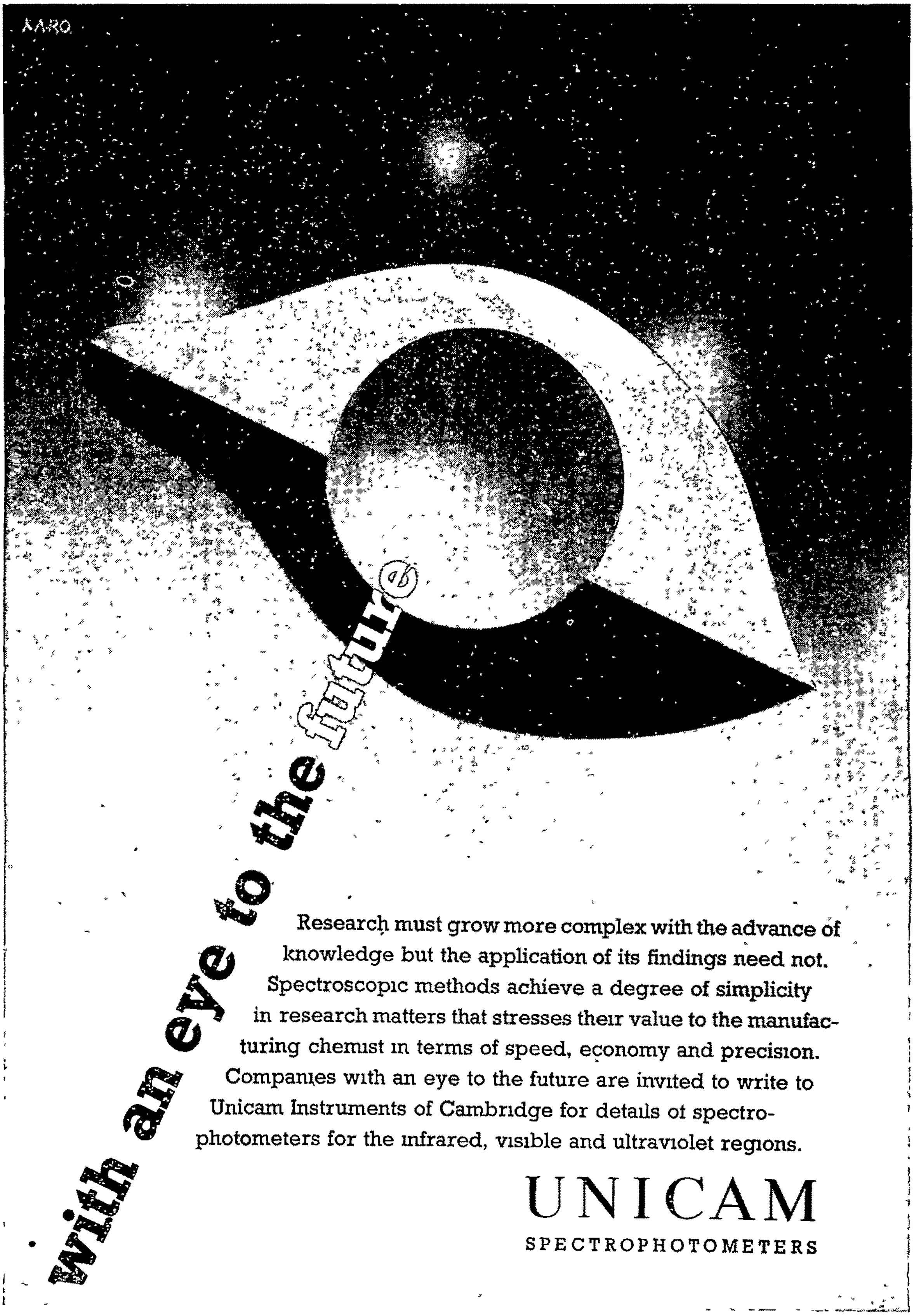
In the interest of *accuracy*

In the field of scientific photography, where performance must be capable of prediction and control within close limits, the consistently high quality of Ilford products has more than usual significance This accounts for the regular use of Ilford sensitised materials by scientific and industrial research organizations, both great and small, in every part of the world



ILFORD **PHOTOGRAPHIC MATERIALS**
in the Service of Science

ILFORD LIMITED ILFORD LONDON


KARO
with an eye to the future

Research must grow more complex with the advance of knowledge but the application of its findings need not. Spectroscopic methods achieve a degree of simplicity in research matters that stresses their value to the manufacturing chemist in terms of speed, economy and precision. Companies with an eye to the future are invited to write to Unicam Instruments of Cambridge for details of spectrophotometers for the infrared, visible and ultraviolet regions.

UNICAM

SPECTROPHOTOMETERS

NATURE

No. 4447 SATURDAY, JANUARY 22, 1955 Vol. 175

CONTENTS

Page

Science in Industry Material and Human Factors 137

Formation and Composition of Coal By Dr L Horton 139
Furan, its Homologues and Derivatives By Dr J Idris Jones 140
Science and Technology of Textile Fibres 141
Birational Geometry By Prof H T H Piaggio 141

Science and Adult Education the Role of the University Extramural Department By Dr H. D Turner 142
Radiation Hazards in Industry By D R R Fair 143
Research Association of British Rubber Manufacturers Opening of New Laboratories near Shrewsbury 145
Treatment and Disposal of Sewage Sludge 146

Obituaries
- Prof H Terrey 147
- Mr F B Stead, C B E 148

News and Views 148

Geneva Laboratory of the Battelle Memorial Institute By Frank C Croxton 152
The Colombo Plan Technical Co-operation Scheme 153
Biology and a General University Education By W B Yapp 153
Gaseous Electronics Conference in New York By Prof F Llewellyn Jones. 154
Production of Town Gas by Gasification Processes 156
Medical Research Council Report for the Year 1952–53 By Dr G Lapage 158
Forestry in the Gold Coast Report for the Year 1952–53 By Prof E P Stebbing 158
J -S Bailly, an Eighteenth-Century French Savant 159
A Detailed Radio Map of the Sky By Prof J D Kraus and H C Ko 159
Possible Site and Mode of Action of Certain Lipotropic Macromolecules in Tuberculosis By Dr J E Lovelock and Dr R J W Rees 161

Letters to the Editors
- Use of Electronic Digital Computers in Optical Design —Gordon Black 164
- An Interpretation of the Long-Spacing Intensities of Calcium Stearate Monohydrate —E Stanley 165
- Formation of Compact Pieces of Grey Tin —Dr E O Hall 165
- Structural Breakdown of Cement Pastes at Constant Rate of Shear —G H Tattersall 166
- Benzoin as a Fluorescent Reagent for the Detection of Germanium —N Appala Raju and Prof G Gopala Rao 167
- Chemical Properties of a Plasma Factor accelerating Hæmoglobin Recovery in Bled Rabbits —J Toha, I Eskuche, F Abarca, F Salvatore and G Hodson 167
- Reconstruction of Coupled Phosphorylation in the Succinic Oxidase System —Dr Lars Ernster, Olov Lindberg and Hans Low 168
- Inactivation and Activation of Liver Phosphorylase —Prof Earl W Sutherland, jun , and Walter D Wosilait 169
- A New Amino-Acid from Apples —Mrs G Urbach 170
- Infra-red Spectra of the New Proline Derivative from the Apple —Dr A C Hulme and Prof F C Steward 171
- Consideration of the Vi-phage Types of *Salmonella typhi* on a Structural Basis —Dr E S Anderson 171
- Effect of Aeration on the Formation of Nitrate-reducing Enzymes by *Ps aeruginosa* —F M Collins 173
- The Long-finned Tunny, *Germo alalunga* (Bonnaterre), in British Seas —Denys W Tucker 174
- Triploid Nauplii of *Calanus finmarchicus* —J P Harding and Dr S M Marshall 175
- Structure of *Vertebraria* —J Sen 176
- Presence of Nucleus and Cytoplasm in the Mature Vessel Elements and Fibre Tracheids in Japan Jute Plants —A J Mia 177
- Revision of Supposed Jurassic Angiosperms from New Zealand —D R McQueen 177
- A Seed-borne Nematode Infestation in Annual Asters —E B Brown 178
- The Genetic Component of Language —Prof C D Darlington, F R S 178

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO , LTD., ST. MARTIN'S STREET, LONDON, W C.2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd , Crown House, 143–147 Regent Street, London, W I
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

'Kodak' recording papers and films cover every application of cathode-ray oscillography and electro-cardiography.

They give you speed to match the fastest light-spot, emulsions to suit every light source, contrast and resolution that are more than adequate

For the record...

'Kodak' Recording Films
R 20 Medium-speed blue sensitive Very high contrast
R 55 High-speed ortho High contrast
R 60 High-speed panchromatic Medium contrast

'Kodak' Recording Papers
RP.20 Rapid blue-sensitive High contrast
RP 25 Rapid ortho Moderately high contrast
RP 30 High-speed blue sensitive Medium contrast,

Available in a wide range of standard sizes

The auto-developer shown above is part of the 'Minirack' oscillograph equipment made by Southern Instruments Ltd, who recommend the use of 'Kodak' Recording Materials in their equipment

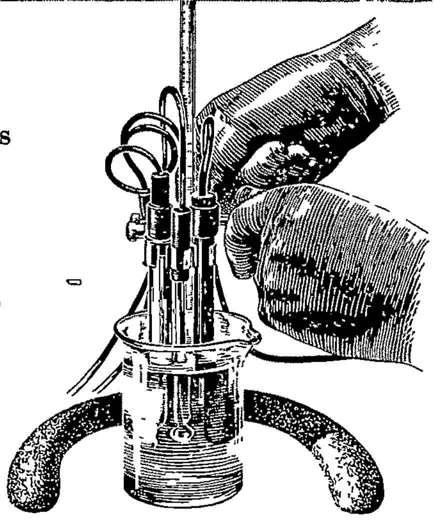
Kodak
RECORDING MATERIALS

Please write for the new booklet 'Kodak Recording Materials'

Kodak Limited, Industrial Sales Division, Kodak House, Kingsway, London, W C 2

'Kodak' is a registered trade-mark

E·I·L pH ELECTRODES



There is an extensive range of E.I.L. electrodes to suit almost every application of pH measurement, from micro electrodes for the analysis of laboratory samples to industrial electrode systems capable of dealing with flows of several hundred gallons per hour. Special types can be made on request. A catalogue is available.

E·I·L the pH people pH

ELECTRONI[illegible] INSTRUMENTS LTD
RICHMOND · SURREY · ENGL[illegible] RICHMOND 5656

SCIENCE IN INDUSTRY: MATERIAL AND HUMAN FACTORS

THE working conference on research and industrial productivity which was arranged by the Department of Scientific and Industrial Research in association with the British Productivity Council (see *Nature*, January 8, p. 66, 1955) was concerned essentially, as Lord Salisbury emphasized at the opening luncheon, with the scientific aspects of productivity. Its discussions in general did not deal directly with research in technology; they were concerned rather with the directions in which further research in such matters as alternative methods of working, work study and industrial operations and relations generally could contribute to the more effective utilization of existing knowledge, the reduction in the time required for the development of technical innovation and the improvement of industrial productivity in general. The conditions which determine the rate of technical innovation were critically and carefully examined, and numerous suggestions were made as to further scientific studies which might enable obstacles to be removed and so improve the standards of both management and operatives as to increase productivity.

The efficiency and progress of industry, as Lord Salisbury observed, is not solely a matter for industry itself. It is a matter with which any government must be concerned, and it may not be without value that the Conference should have drawn from Lord Salisbury this frank admission of government responsibility and of the contribution which the Government itself could make to industrial productivity, not simply by encouraging progressive industry but also by shaping national economic and financial policies so as to create a more favourable climate for higher productivity. Nor is this a matter of party politics. Neither major political party has yet given evidence that it is prepared to make the impartial approach that is required, or to undertake the essential educational work, above all when that runs counter to some particular political prejudice or party dogma.

Here indeed are to be found the two main threads that seem to run through the discussions and which are inextricably mixed. First are the recognition and demand for more quantitative study of industrial operations of all kinds and at all levels, from that of research to development, production, market research and distribution, and using all possible appropriate methods—operational research, measurement of productivity, work study and the rest. When such quantitative study has provided the factual basis for decisions, those decisions cannot be taken and put into practice without consideration of the human and psychological elements. The importance of these elements in making decisions, in providing a sense of participation and in removing the frustrations of industry was the second main thread in the discussions.

That aspect was emphasized from the start. Lord Salisbury said he does not believe it is possible to over-estimate the importance of the psychological approach; this might play an indispensable part in the future in counteracting that boredom and fatigue which are the inevitable result of the increasing mechanization of industry. Moreover, as Sir Ben Lockspeiser pointed out, while the fully automatic factory, for example, is on its way and we cannot choose whether or not to make changes which carry economic advantages in competitive markets, such changes demanded by technology are apt to conflict with habits of work and ideas of management. Some of the old conceptions still current on both sides of industry are quite out of keeping with modern technology, and much fresh thought is demanded—of governments as well as of employers' federations and trade unions—on human as well as technical problems, if an old traditionally minded democracy such as ours is to preserve its freedoms and earn its living in a competitive world.

Sir Ben described the changes connoted, for example, in the coming of the automatic factory as tantamount to a second industrial revolution; but what seems equally clear from the discussions at this Conference is the extent to which a revolution in thought is still required on both sides of industry and indeed among politicians. Even in the research programmes of the Department of Scientific and Industrial Research, Sir Ben noted, it is necessary to study more closely the needs of industry and the conditions under which it operates, to think in terms of costs and economics and human values, as well as of science, in order to achieve right emphasis and apply the results successfully. In confirmation of this, in speaking on economic factors in planning research, Dr. R. M. Lodge, research manager of British Nylon Spinners, stressed the necessity for much more careful attention in planning on the production and sales side a milieu receptive to research ideas, and also insisted on the importance of the human element; he referred particularly to the importance of planning consciously to provide the right atmosphere in which research can flourish and the dependence of research to-day on group- or team-effort.

Dr. Lodge also suggested that, with the present scarcity of scientific and technical man-power, it might be necessary to give much more thought and attention to the best possible means of using the available qualified men, even if it caused rearrangement of the traditional laboratory organization so as to relieve the limited number of more highly trained men, and those most capable of original thinking, of routine activities. The most effective use of our resources of scientific man-power to-day will scarcely be secured without pursuing this principle much more carefully and thoroughly, not only in industry but also elsewhere, including the university laboratories and research institutions, and the science teachers in the schools and technical colleges. The attempt to do so, moreover, will frequently encounter similar obstacles to those which hinder attempts to secure the adoption of technical innovations or more efficient methods of working, namely, lack of human understanding and co-operation.

The critical factor is indeed everywhere the psychological one, and ultimately at whatever level the task of improving industrial productivity is approached, from the research department to the sales department, the real problem is one of communication, in the true sense of the word—of promoting a clear understanding on the part of all concerned of what requires to be done and why, of how it affects them and the contribution which they are called upon to make. While the discussions at the Conference stressed the need for more quantitative knowledge and the importance of taking full account of the human factor, they equally made manifest the extent to which the whole of the research programme of the Department of Scientific and Industrial Research and of the research associations has already been influenced by such ideas and is aimed in one way or another at increasing industrial productivity, interpreted in the broadest sense. Still more, however, did the Conference manifest the extent to which human neglect, prejudice or ignorance persist in preventing the nation from reaping the full benefit of existing knowledge and drawing the greatest possible advantage from its natural resources, even those that, like fuel, are dwindling seriously.

One of the most disturbing papers in this respect was that of Mr. K. T. Spencer, chief scientific adviser to the Ministry of Fuel and Power, on the availability of fuel and its efficient use. Mr. Spencer, recalling the past dependence of the industrial progress of Britain on cheap coal, said that it has yet to be proved whether nuclear energy can restore the age of abundant energy, and at best many years must pass before nuclear energy can replace coal as our main source of energy. Meanwhile, we have to face a continuing fuel shortage which within the next decade may well involve a gap between supply and demand of some 20 million tons of coal per annum. So far, the increasing requirements of industry, with the production of coal declining, have been met by increasing efficiency of utilization, by reducing exports and by increasing the use of oil. Mr. Spencer reminded the Conference that hitherto mechanization has given no spectacular increase in output of coal, and the quality has deteriorated and is likely to continue to do so. It would be unrealistic, therefore, to rely on coal production increasing sufficiently to meet our requirements, and it would be equally unwise to regard with complacency an increasing dependence on imported petroleum. The soundest policy for filling the gap, he said, is to increase the efficiency with which fuel is used.

It is here, in his revelation of the extreme variations in the efficiency with which coal is at present used by different industries and in one and the same industry, that Mr. Spencer is startling and even alarming. He quoted evidence of waste that has persisted virtually unchecked for eighty years since it was condemned by a Commission of Inquiry appointed in 1871; during that period, according to a survey made by the Ministry of Fuel and Power in 1953, the average efficiency of the shell-type boiler had increased by about 10 per cent. Indeed, figures quoted by Mr. Spencer show that in some industries, such as paper and board, bricks and fireclay and cotton, productivity per ton of coal decreased between 1935 and 1948, although on the whole productivity per ton of coal slightly increased. But in individual industries the yield per ton of coal can vary hundredfold: for grain-drying, for example, from 5·6 tons to 224 tons; for beer from 18·5 to 112 barrels; for biscuits from 1 to 20 tons; in laundry work from 0·4 to 5 tons; in bronze and brass founding from 1·7 tons to 20 tons for billets and ingots, and from 0·2 to 2·5 tons for castings; and in continuous kilns for building bricks from 4·8 to 44·7 tons. An investigation of some twenty breweries, for example, by the British Coal Utilization Research Association indicated simple methods the adoption of which would save about 200,000 tons of coal per annum; and, quite apart from this, Mr. Spencer was able to point to some equally startling savings which could be achieved by the substitution of the most efficient plant for the inefficient plant so often used.

The challenge to thought represented by Mr. Spencer's paper is unmistakable, but the very magnitude of the task before us underlines the importance of the task of education. Clearly, a large amount of the information required for a fuel economy advisory campaign already exists; and clearly also the importance of there being within each firm someone abreast of scientific advance and able to appreciate its bearing on the technical activities of the firm is again demonstrated. The major problems are those of the communication of existing knowledge in the most appropriate and effective way, and the means by which the psychological and human obstacles to its utilization are to be overcome.

Here is a challenge to fresh and constructive thought, and indeed to further investigation, as was elaborated in some detail in various papers at the Conference, notably in those by Mr. N. Fleming and Mr. R. M. Currie. Though due weight was given to the technical factors, there was no disposition to over-rate either such factors or the economic factors on which other speakers like Mr. A. H. Wilson, Dr. C. B. Frisby or Mr. D. A. Oliver, for example, laid stress in considering obsolescence, the design of equipment, the organization of work and the exploitation of mineral resources. Whatever fresh facts are required as basis for decisions in particular fields, the overall need is for clear unprejudiced thinking about the whole situation, taking into account the scientific and technical as well as the economic and psychological factors before determining policy and action.

This challenge to study and thought emerges again and again in the most diverse papers presented at the Conference. It is the keynote, for example, of Prof. C. F. Carter's analysis of the economic factors in technical innovation and the justification for the studies of the obstacles to such innovations in business which are at present being examined by the Science and Industry Committee of which he is chairman. Prof. S. Zuckerman's discussion of the utilization of raw materials, with its emphasis not only on efficiency and the elimination of waste both in production and use, but also on the desirability of living on income in this respect rather than on capital, is no less challenging. Long-term appreciations of the supply position make bigger demands on forethought than the short-term views which he criticized, and thought as well as fresh investigation will be required if renewable resources like cellulose are to replace wasting assets such as coal and petroleum as raw material for synthetic processes. Prof. Zuckerman pointed out how far we are from significant supplies of synthetic foodstuffs: the mechanism of photosynthesis is not yet fully understood, let alone reproduced in the workshop. It would be of very doubtful value to base any efforts in that direction other than on the production of nutrients obtainable at low cost of energy and materials from renewable assets.

The possibility of conflict between short-term and long-term considerations was admitted by Prof. Zuckerman, and it should be obvious that, when all that is possible has been done to secure the economic elimination of waste in production and utilization and the efficient use and co-operation of labour, the selection of materials and processes contributing to the soundest economy and conservation of natural resources involves decisions which can scarcely be taken without government approval and support. If little was said specifically on this point at the Conference, apart from Lord Salisbury's rather oblique reference at the opening luncheon, the vital bearing of government policy on industrial productivity and the conservation of resources was repeatedly indicated. The large savings in coal per passenger or vehicle mile which Mr. Spencer gave as possible by substituting electric trains for steam trains, or diesel locomotives or diesel road coaches for steam locomotives and trains, are unlikely to be realized without a change in government policy towards the re-equipment of British railways, for example. If, moreover, British industry is, as has been suggested, less willing than formerly to take risks, government policy can be the determining factor as between supporting weakness and encouraging initiative and enterprise.

Even here, however, we are concerned with the human factor. In the re-equipment of the railways, for example, the provision of the capital resources may well prove a small problem compared with that of the human adjustments and the revolution in working practices that will be involved in the replacement of steam working and the efficient use of new equipment. The problem of education and communication of ideas, knowledge and purpose is fundamental at all levels. Here the Conference seemed to be somewhat disappointing. What is needed even more urgently than the investigations in the field of work study, which Mr. Currie suggested, is a more determined effort to promote the understanding and confidence between management and workers on which high productivity depends.

Admittedly, evidence that management is alert and competent to take full advantage of advances in technique can help to establish such confidence. So, too, could the knowledge that research, such as Mr. Currie suggested, is proceeding into improved methods of operating, from the health and safety points of view, the economic, the physiological and the psychological points of view. But if the results of those researches are to be fruitful, the attempt to encourage receptivity to new ideas and practices must be proceeding now, and restrictive practices and ideas attacked at all levels, alike among employers' associations and among the trade unions. The promotion of a climate of opinion favourable to technical innovation and industrial productivity should receive the first priority.

The Conference gave little lead as to how this task is to be undertaken, or as to the most appropriate methods by which it could be approached. Dr. C. B. Frisby indicated the need for further consideration of means of communication as well as for the co-operation of different specialists. Dr. A. King, in summing up, recognized the value of a combined approach, and he and Dr. F. C. Toy both emphasized the extent to which the Department of Scientific and Industrial Research, with its network of research associations, is now regarded by the Government as one of the major means for transmitting ideas to industry. The other main national agency is the British Productivity Council, with its regional organization and circuit system, which endeavours to bring management and workers together in every main industrial area, using modern methods of presentation. These bodies have already done much, and it is probable that more will be done, particularly by the research associations, as their knowledge of the human aspects of production and innovation increases. If, however, the full co-operation of the human element is to be secured in the application of science in industry, commerce and the public services, from the level of director to that of operative, this problem of communication and the most effective methods by which it is to be achieved are, as Mr. L. T. Wright insisted at the Conference, of supreme importance. It is the problem to which, above all, the Lord President of the Council should give his immediate attention in following up the Conference, and it could fittingly engage the attention of the Parliamentary and Scientific Committee as well as of the British Productivity Council and all those bodies which, whether represented or not at the Conference, are concerned with the development of industry and the economic future of Britain.

FORMATION AND COMPOSITION OF COAL

Coal

Its Formation and Composition. By Dr. Wilfrid Francis. Pp. viii+567. (London: Edward Arnold (Publishers), Ltd., 1954.) 84s. net.

MANY coal-producing countries are to-day faced with urgent problems concerning their supplies of fuel. Some of these problems relate to the more efficient use of the available supplies of coal; some are concerned with the rapidly diminishing reserves of certain all-important types and the employment, where possible, in their stead of more abundant kinds

The solution of these difficult and varied problems will need the integrated effort and experience of specialists in many fields The role of the fuel technologist is to effect this integration and to translate it into practice in the light of his own specialized knowledge and experience It is therefore a noteworthy occasion when a comprehensive treatise appears on the subject which is the foundation of all fuel technology relating to coal, namely, the formation and composition of the fuel itself

In presenting his book it is the author's intention "to help serious students of fuel technology and coal chemistry in all stages of their work" This he will undoubtedly do, because as the knowledge and experience of the practising fuel technologist widen, he will seek more and more frequently to find the key to the solutions of many of his problems in the constitution of the coal itself

All studies of the constitution of coal must of necessity include considerations of the original vegetable matter from which the coal was formed and of how the various constituents changed, under different conditions of climate and environment, during the transformation into coal. Roughly one-half of the book is devoted to these matters The subject-matter is illustrated by numerous photomicrographs the reproduction of which is beyond reproach except in certain isolated cases where the originals had been published previously by their various authors in a form not suitable for further reproduction Many students will feel, however, that they would have obtained more help from the illustrations if, in some cases, the various plant tissues mentioned in the text had been suitably indicated

The remainder of the book deals largely with coals of the types found in Great Britain and with certain of the methods which have been used for obtaining some insight into the actual chemical structure of the coal substance As the coal matured through the various stages from peat to anthracite, there were accompanying changes in both structure and physical properties Although coals at all stages of maturity are mixtures of the products of transformation of many different types of vegetable entities, their properties in general can be fairly accurately assessed from a knowledge of their elementary composition On this fact are based all systems of practical coal classification Failure occurs only in unusual circumstances It seems to the reviewer that little is to be gained, except possibly in the more strictly scientific investigations, by the adoption of the elaborate system proposed by the author, which is based on the composition of the individual components of the coals

It is somewhat surprising to find no mention of the work of Millott, Cope and Berry in the discussion of Hilt's law Their examination of the coal seams encountered in a deep boring at Pie Rough, North Staffordshire, during a war-time search for oil provided a striking illustration of the truth of the law

Occasionally a statement appears for which there is little or no experimental support For example (p 313), ". . nitrogen and sulphur can replace oxygen in many ring structures with little effect upon the properties of the coal" The problems of coal constitution would be greatly simplified if such a substitution could be made with certainty under conditions where the ring structure of coal was otherwise undisturbed

These are minor criticisms The author has presented to students of fuel technology a book which deserves the highest praise and which will rapidly occupy a place of importance in the literature of the subject L Horton

FURAN, ITS HOMOLOGUES AND DERIVATIVES

The Furans

By A P Dunlop and F N Peters (American Chemical Society Monograph Series) Pp. xix+867 (New York Reinhold Publishing Corporation, London Chapman and Hall, Ltd , 1953) £7 4*s*. net

FURFURAL, accidentally discovered by Dobereiner in 1821 and christened "artificial oil of ants", has to-day become a major commercial chemical. Its rapid rise to industrial maturity during the past thirty years constitutes one of the greatest achievements of chemurgy—the science concerned with the utilization of agricultural waste materials in industrial processes The pioneering work of LaForge on the utilization of corn-cobs, the brilliant researches of Miner and Brownlee on oat hulls and the classic investigations of Mains on the furfural–water system are prominent landmarks in this notable development

A derivative of furan, furfural, by virtue of its chemical reactivity, has become the source of many other important furan derivatives With the advent of cheap and plentiful furfural, its industrial applications multiplied apace, and interest in furan chemistry, both in academic and industrial laboratories, received considerable stimulus So voluminous is the literature on the subject to-day that the compilation of a monograph on "The Furans" was a truly monumental effort The authors, eminently qualified to undertake the task, are to be congratulated on being the first to attempt a complete treatment of this important and rapidly expanding field of chemical endeavour, and the work ranks as a most valuable contribution to chemical literature To keep the monograph within reasonable proportions (as it is, it runs to more than eight hundred pages) some omissions were inevitable Thus, anhydrides, for example maleic and phthalic anhydrides, and γ-lactones which might in one sense be regarded as furan derivatives, and compounds wherein the furan ring is fused to another cycle, are not included, and the hydrogenated furans are only discussed in relation to their commercial importance

Starting with a general review of the chemistry and structure of the furan series of compounds, the authors proceed to a detailed discussion of the chemistry of furan, its homologues and derivatives with halogen, nitro, hydroxy, amino, keto, carboxyl, aldehyde and metallic groups The chapters on furfural, its production, analytical methods, physical and chemical properties are extremely well written This first part of the monograph concludes with a review of the hydrogenation and cleavage reactions of the furan nucleus The second half is devoted to the industrial applications of furfural as a chemical intermediate, industrial solvent and for resin manufacture. Pride of place in the first role goes to the use of furfural for the synthesis of adiponitrile, key intermediate in the nylon synthesis. This use is now the largest single outlet for furfural A propitious combination of physical characteristics makes the aldehyde a valuable and selective solvent, and both furfural and furfuryl alcohol find extensive use in the manufacture of synthetic resins These applications are fully covered and a compilation of patents relating to furan resins is appended

The book has many excellent features and is very well produced It is authoritative, and, within the limits defined, comprehensive It is to be regretted that the high price, possibly justified in the light of present-day production costs and the labour involved in its preparation, will severely restrict the sale of this most valuable treatise J. IDRIS JONES

SCIENCE AND TECHNOLOGY OF TEXTILE FIBRES

Matthews' Textile Fibers

Their Physical, Microscopic, and Chemical Properties. Prepared by a Staff of Specialists under the Editorship of Herbert R Mauersberger Sixth edition Pp. x+1283 (New York John Wiley and Sons, Inc., London Chapman and Hall, Ltd., 1954) £6 12*s* net

IT is just fifty years since the first edition of Matthews's "Textile Fibers" appeared—a half-century that has witnessed the birth and rapid expansion of modern textile research, and the concurrent development of the technology of man-made fibres to its present size and importance As was inevitable, during such a period, a steady stream of revisions has been necessary to keep such a fundamental reference work abreast of the times. The present edition, the sixth, worthily maintains the succession As in the case of its immediate predecessor, it consists of a series of monographs, by distinguished American authors, which together cover the whole field of the textile fibres—natural, artificial and synthetic, their identification, properties, uses and assessment

The weakest section is that devoted to fibre-testing methods, which remains practically unaltered from the previous edition Whereas much of the early testing apparatus described has no modern interest and could have been omitted, no reference is made to the considerable volume of work that has been published on the bending properties of fibres, abrasion resistance, fatigue effects and creep phenomena Of the ninety-five references contained in the bibliography of this section, only eight refer to work carried out within the past ten years There is also a serious double transposition in the text on pp 1245–1247, which should be corrected in any future impressions

In compensation, the section devoted to the microscopical and physical properties of wool, revised to include recent electron-microscopic studies, is excellent, as is also that dealing with the interpretation of X-ray fibre photographs, written for the non-specialist reader This latter section appears for the first time in this edition The sections concerned with man-made fibres have been considerably revised and extended. and, so far as the inevitable delays of publication allow, they are up to date The need for a revision of these sections was, in fact, one of the chief reasons for the present edition, and it has been admirably met

The book is well indexed, and the bibliographies appended to each section greatly enhance its value as a work of reference As "a textbook for use in colleges and technical schools" in Great Britain, its strongly American flavour, inevitable in view of the general authorship, is a decided disadvantage Nevertheless, it will continue to be used for reference purposes, in the future as in the past, because of the scope and competence of its contribution to textile knowledge

BIRATIONAL GEOMETRY

Methods of Algebraic Geometry

By Prof W. V D Hodge and Dr. D Pedoe Vol 3, Book 5 Birational Geometry Pp x+336 (Cambridge At the University Press, 1954) 40*s* net

THE scope of this book is more restricted than might have been expected from the title It does not deal with birational geometry as a whole, for the fundamental properties discovered by the great Italian geometers have been entirely omitted The reason for this is explained in the preface The authors' intention is to explain methods, not results or a unified theory, and not all methods, but only those based upon the modern abstract algebra of rings, ideals and valuations These methods are largely due to the recent work of O Zariski The reader is assumed to be already versed in the ordinary methods of algebraic geometry On the other hand, no knowledge of abstract algebra is assumed, beyond that contained in the earlier volumes It is a great convenience that the geometer will find in this volume and the earlier ones all the algebra he needs, though it entails that nearly half of this volume is algebra rather than geometry

This volume contains four chapters The first deals with the theory of ideals in a commutative ring, including prime and primary ideals, remainder-class rings, subrings, extension and quotient rings, modules, multiplicative theory of ideals, and integral dependence The second chapter deals with the arithmetic theory of varieties and applies the results of the first chapter to geometry Great stress is laid upon projectively normal varieties, which are used extensively in the more advanced parts of birational theory The third chapter deals with the concept of abstract algebra known as the valuation of a function field This generalizes the classical theory of a branch of an algebraic curve, and is of fundamental importance in the theory of birational transformations The authors point out that many of the results could have been obtained more simply and elegantly by Weil's method, using what are called specializations However, it is unlikely that a complete theory of birational transformations can be built up without valuations, so geometers should study this method Valuation theory can also be applied to the theory of numbers, but the account here is restricted to what is required for geometry

The fourth and last chapter is entitled "Birational Transformations" Most of it is devoted to problems concerning multiple points A problem still unsolved is whether we can obtain, for every algebraic variety, a birational transform without multiple points. Some light is thrown upon the structure of multiple points by Zariski's local uniformization theorem No less than seventy pages are devoted to the proof and applications of this fundamental theorem The volume concludes with two pages of bibliography and bibliographical notes, and an index.

H. T H PIAGGIO

SCIENCE AND ADULT EDUCATION

THE ROLE OF THE UNIVERSITY EXTRAMURAL DEPARTMENT

By DR. H. D. TURNER

University of Sheffield

IT is extremely difficult to define clearly the aims and purposes of adult education. This is due partly to the number of different activities and subjects which it embraces, partly to the various ends which it is designed to serve, and partly to the number of organizations concerned in its provision. A precise definition of science in adult education is impossible for similar reasons.

The general case for the inclusion of science as a humane study in adult education has been well stated by Peers[1] in his report to the Universities Council for Adult Education. There are, however, other equally important aspects of science and technology with which extramural departments may be usefully concerned, and it is at least arguable that teaching in these fields is one of their proper functions.

The following list includes most of the activities which, collectively, may be regarded as constituting science in adult education.

(1) The teaching of separate subjects such as biology, chemistry, physics and geology. These may be presented at various levels ranging from the most elementary introductory lectures to descriptions of recent advances.

(2) Courses, at various levels of presentation, in all branches of technology.

(3) Lecture series in the history of science and technology.

(4) Discussion of the impact of science and technology on society.

(5) Groups of special lectures in science and technology which may, for example, supplement normal courses in history and economics.

At the moment there is a general tendency, reinforced by the conclusions of Peers, to suppose that at the advanced level (1) is too difficult and at the elementary level is outside the scope of extramural departments; that (2) is not the concern of extramural departments; that (3) is unpopular and hence not worth attention; that (4) is not science and therefore not suitable for inclusion in science teaching; and that (5) is better done by the appropriate specialist.

We may say at once that (1) and (2) should, at the elementary level, be provided by local education authorities; and that, in the main, the problems raised by the impact of science and technology on society should be of interest to the Workers' Educational Association, since these problems are similar in origin and effect to those which stimulated the early development of the Association.

Many successful courses of the type included under (1) above have been given at Sheffield during the past six years. The Extramural Department has usually arranged and administered the courses, while the lecturing has been done by internal members of the University staff. The form of such courses must always be adapted to the requirements of potential students. For example, lectures and demonstrations on recent advances in various sciences are probably best given as one-day Saturday courses, since this is often a free day for graduates in teaching and in industry; but such provision should be supplemented, where possible, by longer residential courses. These, although more difficult to organize than evening lectures, offer great advantages; demonstrations and practical work are more easily provided, and the opportunities afforded for discussion and general social activities enormously enhance the value of the course. It is not difficult to believe that such residential courses may well become one of the most important features of adult education in the future. Sometimes, however, it may be necessary to stimulate interest in a subject, and form a class, by a series of progressive courses as, for example, in recent developments in the teaching of geology. A single public lecture had shown that a certain amount of interest existed in a particular area. This lecture, therefore, was followed by a short course on local geology which was so successful that it led to a longer course (of twenty meetings) on "The Scenery and Resources of Britain". From this has developed an intensive study course, attended by twenty-five students, which covers much the same ground as the first-year course in geology at the University; and this sequence is being increasingly used for the development of courses in other subjects. Courses of this type are generally restricted to the University and to large centres of population. In these the Department frequently organizes courses in co-operation with the local technical colleges, where adequate lecture rooms and reasonable facilities for practical work and demonstrations are normally available. Thus these educational needs of adults in the areas are provided by the resources of the technical college supplemented where necessary by those of the University.

Most universities have technological departments which often serve both local and national industry. There have been many interesting developments in these departments, such as the establishment of post-graduate schools of study, which are organized without the help of extramural departments. At the same time, the extramural department, with its contacts in industrial and educational circles, may often be able to advise in the provision and help with the organization of many worth-while courses, the need for which is not always immediately obvious. For example, at Sheffield the Extramural Department, in co-operation with the Departments of Metallurgy and Fuel Technology, has started a series of very successful advanced residential courses in "Fuel and Metallurgical Problems of Jet Engines" for engineer officers in the Royal Air Force; and there are obviously many similar fields in which the Extramural Department can pioneer new developments of mutual benefit to the Services, the university and industry.

Courses in the history of science and the history of technology are, unfortunately, rarely included in any educational scheme. There are many reasons why the universities should sponsor the teaching of these subjects. Their staffs include the necessary specialists with the requisite facilities. The history of science and technology covers ground that is common to the arts and science; and the problems of liberalizing science courses and of interesting arts students in science may be solved by courses in these subjects.

Experience in the field of extramural studies shows that there is considerable interest in such topics and in the philosophy of science. A number of experimental courses in the history of science have been given, and in these the 'case-book' method developed by J. B. Conant at Harvard University[2] has been used and considerably extended. In the most successful courses various important experiments in the history of science, such as the analysis of light, the discovery of oxygen and the discovery of the electron, have been described and demonstrated, and their scientific and technological consequences discussed. One surprising feature of these lectures has been the large attendance of senior sixth-form grammar school pupils.

It has already been suggested that courses on the impact of science on society might very well be suitable for the Workers' Educational Association. Such courses have been given at the request of local Association branches; but generally the response has been very poor. Very much more could and should be done in this field; a technological society is obviously extremely unstable if its members are ignorant of and uninterested in technological developments and the problems which these pose.

There are certain parts of courses in history and economics in which contributions from scientific specialists are essential. Only a scientist can adequately assess the influence of scientific discoveries on the climate of scientific opinion and on technological development. Such experience as we have had indicates that, provided problems of continuity can be solved, joint extramural courses by, for example, a historian and a scientist are very successful.

Certain general conclusions may be drawn from what has been said above. For example, it seems desirable that extramural staffs (at any rate in science) should be primarily advisers and organizers, although they should obviously keep in touch with their subjects by research and by internal and external teaching. This means, of course, that the bulk of extramural science teaching will be done by internal members of university staffs. The university, however, has obligations to the community in which it is situated, and to the tax-payer who nowadays largely finances it. The discharge of such obligations may very well involve, among other things, the explanation of the nature, purpose and results of the research work which is being done by universities.

Although extramural departments should be prepared to co-operate with all who seek their help, their main concern should always be with the provision of courses, delivered at a university level, for those who are capable of benefiting from them. In practice, these will probably be ex-grammar school people whose spare time is often limited. Hence, much of this provision must be in the form of short intensive one-day, week-end or residential courses and series of, say, not more than six evening lectures.

The activities of extramural departments should be widely known and this means that extensive advertising of courses is necessary. This has the additional advantage that students recruited to an advertised course form a reasonably homogeneous group.

The extramural department should, at this time, be encouraged to investigate every possible field of activity open to it. Experimental work and courses of all kinds should be tried; and this means that its activities should not be artificially restricted by financial straitjackets or by out-worn regulations. For example, sixth-form grammar school students are not officially admitted to extramural lectures and classes. Yet they are adult; they are capable of absorbing information at the appropriate level; they are prepared to turn up voluntarily in large numbers for lectures on the history of science and on modern scientific and technological developments; and they are the extramural students of to-morrow. If they are encouraged to-day to look to the university, through its extramural department, for their further cultural education, the problem of recruitment to classes in the future may very well solve itself.

There can be no doubt that in order to achieve all this it will be necessary for extramural departments to be directed solely by the university council and senate working through appropriate committees. This would give the departments the necessary status and flexibility of approach; and the obvious corollary to this is that the money required to finance their activities should be provided by the University Grants Committee as for other university departments.

---

[1] Peers, Robert, "Science in the Extramural Work of the Universities" (Universities Council for Adult Education). See *Nature*, **174**, 166 (1954).

[2] Conant, J. B., "Harvard Case Histories in Experimental Science" (Harvard University Press, 1950).

RADIATION HAZARDS IN INDUSTRY

THE third conference of the British Occupational Hygiene Society was held on November 1 in the lecture theatre of the London School of Hygiene and Tropical Medicine, the subject of the conference being a consideration of the radiation hazards in industry. The chair was taken by Prof. E. J. King (Postgraduate Medical School of London). The subject was originally introduced at the second conference of the Society held in April 1954 when Dr. W. G. Marley (Atomic Energy Research Establishment, Harwell) delivered a paper on the permissible levels of exposure to ionizing radiations and radioactive materials. In this paper Dr. Marley discussed the basic 'tolerance' level or maximum permissible level for X-rays or gamma-rays, and then proceeded from the basic 'tolerance' for X-rays and gamma-rays to calculate the permissible exposure to various types of radiation, allowing for their relative biological effectiveness. Similarly, the maximum permissible body-burden of radium is a valuable starting-point for the calculation of maximum permissible levels of different radioactive isotopes taken into the body. Dr. Marley described the method by which international agreement on maximum permissible levels has been reached. The experience of the atomic energy departments and of radiobiological specialists in the United States, Canada and the United Kingdom has been compared in a series of tripartite conferen[illegible] commencing in 1949. Since then, data have been considered by the International Commission on Radiological Protection during the meetings of the International Congress of Radiology in 1950 and

1953 The third conference of the British Occupational Hygiene Society therefore started with a knowledge of the maximum permissible levels and with the assurance that they are internationally agreed levels

Dr A S McLean (principal medical officer of the Industrial Group, United Kingdom Atomic Energy Authority) opened the third conference of the Society with a paper on the health of workers exposed to ionizing radiation He referred to the history of man's use of atomic energy since the turn of the century up to the present time, when he has learned to exploit it on a grand scale. Dr McLean was less concerned with the effects of massive doses of radiation than with the pattern of injury which may be the outcome of long-continued exposure just above the critical level for these effects The consequences of chronic over-exposure have been seen in several groups of human beings, including painters of luminous dials, miners of radioactive ores, and pioneer workers in the scientific and medical fields , in addition, there has been a vast amount of experimental work with animals From these observations it is known that the sensitivity of any organ of the body to the effects of irradiation is generally a function of the rate of cellular activity in that organ, so that the blood-forming and reproductive tissues, for example, are more easily damaged than the nerve tissue of the brain Nevertheless, a tissue of relatively low sensitivity may be damaged exclusively when it is the site of selective localization of a radioactive substance which has entered the body. Thus, radiation protection contains two distinct problems which are concerned with the irradiation of whole or part of the body from the outside and with the irradiation of selected organs of the body following uptake of a radioactive substance by breathing or by swallowing Dr McLean discussed both these problems and listed the main body organs involved Of particular interest to the medical officer is the detection of radioactivity in the excreta , but since in some cases this involves the determination of micro-micro-gram quantities of radioisotopes, the radiochemistry involved is not easy Dr McLean concluded with a review of the comprehensive medical facilities which are used in the selection of workers and in the maintenance of health in the workers employed in the atomic energy industry

The second paper, dealing with radiation safety in the Industrial Group of the United Kingdom Atomic Energy Authority, was by Mr. D R R Fair (head of the Health Physics Department, Windscale Works, Sellafield, Cumberland) He reminded the audience that, in thinking of radiation safety in industry, they must not think of scientists working in laboratories but of factory managers employing process workers and skilled craftsmen working in factories He discussed external irradiation and the design office's contribution to the safety of the worker in the provision of radiation shields and the layout of plant and equipment to make use of distance for safety

The contribution by works management to safety is called for when plant has to be maintained or modified A decision has to be made whether to postpone operations in order to allow short-lived fission products to suffer radioactive decay or whether the radiation field may be reduced by decontamination of the plant Before work commences, management has to decide whether local radiation shielding must be built, the workers have to be briefed on the method and sequence of work they are to carry out, and the time the worker is in the radiation field ha to be carefully controlled Mr Fair then turned t the harder task of the atomic energy industry, th protection of the worker from the inhalation c ingestion of radioactive materials The design office have provided all-welded plant using a speciall corrosion-resistant stainless steel, liquid transfe mechanisms by hypodermic needle, and adequat ventilation of working space with controlled directio of airflow and proper facilities for the workers t maintain the highest levels of personal hygiene. Th management exercises safely control during mai tenance work by reducing air contamination to minimum, controlling both the volume of air whic is contaminated and its disposal, and by providin the worker with clean air and full head and bod cover while he is on the job Mr Fair discussed i some detail the methods by which managemer achieves these aims He concluded by reviewing th position and responsibilities of the health physici in an atomic energy works

Mr W Binks (Radiological Protection Service (the Ministry of Health and the Medical Researc Council) presented the third paper, and dealt wit protection against X-rays and gamma-rays in th industrial field He was particularly concerned wit radiation hazards in ordinary industries Exper mental data were given on the direct radiation outpu from X-ray tubes and from radioactive isotopes, o the degree of scattering produced under differer conditions and on the absorption of both direct an scattered radiation in materials such as lead, bricl concrete and soil Mr Binks discussed in detail th solution of a number of problems encountered i designing an industrial radiological establishmen Since the safety of personnel working with ionizin radiations depends as much upon adherence t particular techniques as upon the provision (structural shielding, Mr. Binks included details (the various monitoring techniques which may b adopted to assess the actual dose received by worker Finally, he described the help which it is anticipate the Radiological Protection Service will give t industrial managements in designing radiologic establishments and in carrying out radiation surve and personnel monitoring tests.

The final paper at the conference was by M F R Farmer, assistant director, production, (the Industrial Group, United Kingdom Atom Energy Authority, Risley, who dealt with the safet criterion in atomic energy Mr Farmer made review of the hazard-level in industry as measure by the death-rate and compared this in the workin population age-group with the death-rate due t natural causes and to violence He quoted deatl rates of 10–12 for normal industry, 30 due to violenc (including 12 on the roads), 80 for the mines and 14 due to natural causes, all per 100,000 In a civilizatio with a rising standard of living, changes in the publ attitude to such figures may be expected and demand will arise for preventive action to be take

Mr Farmer posed the problem of the new industr and asked what should its objective be While it ma be argued that a zero risk is highly desirable th in the absolute sense, is not obtainable It seen reasonable to set as a target for a new industry th it must be comparable with the best in other indu tries Looking back over other industries, it probable that safety has been influenced by the nee of the industry to sell its products economically in competitive market, and the cost factor in safet must not be lost sight of if the atomic energy industry is to make its mark in the national economy. Mr. Farmer concluded that the safety aim of the atomic energy industry must be for perfection within an economic framework that will encourage the development of the industry.

Each paper presented to the conference was followed by a period of full discussion in which many points of principle and some of detail were discussed. It was agreed that the safety-level established in the atomic energy field compares very favourably with much of established industry, but that a larger experience of radioactive work in industry will be needed before final conclusions can be drawn.

D. R. R. Fair

RESEARCH ASSOCIATION OF BRITISH RUBBER MANUFACTURERS

OPENING OF NEW LABORATORIES NEAR SHREWSBURY

On November 23 H.R.H. the Duke of Edinburgh officially opened the new laboratories and headquarters at Shawbury, near Shrewsbury, of the Research Association of British Rubber Manufacturers. Some three hundred persons were present, drawn from all sections of the rubber and allied industries, together with representatives of government departments and other organizations connected with the rubber industry, and after the opening they were able to visit the premises and inspect the displays showing various aspects of the Association's work. In his speech to the company the Duke referred to the obligations of industry towards co-operative research and its results, and put in a strong plea for yet more generous financial support by industry of the Association's work. He also stressed very much the problem of getting a research association's results applied in industry—"probably the most complicated and elusive problem confronting the industry to-day".

The ceremony formed a fitting and stimulating climax to the efforts that have been made during the past years to provide the Association with premises adequate for its growing needs. Founded in 1919, the Research Association of British Rubber and Tyre Manufacturers (as it was first called) began work in two rooms in University College, London, and then in 1922 premises were acquired in Lansdowne Road, Croydon. For many years these met the Association's needs; but the very success of its work, and especially the demands made on it during the Second World War, led to an expansion that seriously overtaxed the available space. By 1948 it became clear that the only solution was to find entirely new premises, and bearing in mind that the 'centre of gravity' of the rubber industry lies in the Midlands rather than the London area, the Council of the Association decided, after exhaustive inquiries and searches, to acquire premises already existing at Shawbury. These were purchased in January 1952, and since then the task of adapting them has proceeded steadily. Now that task is complete and the premises have been officially opened, the industry possesses a research station of excellent design, attractive in external appearance and interior finish, and fully equipped for the important work that lies before it.

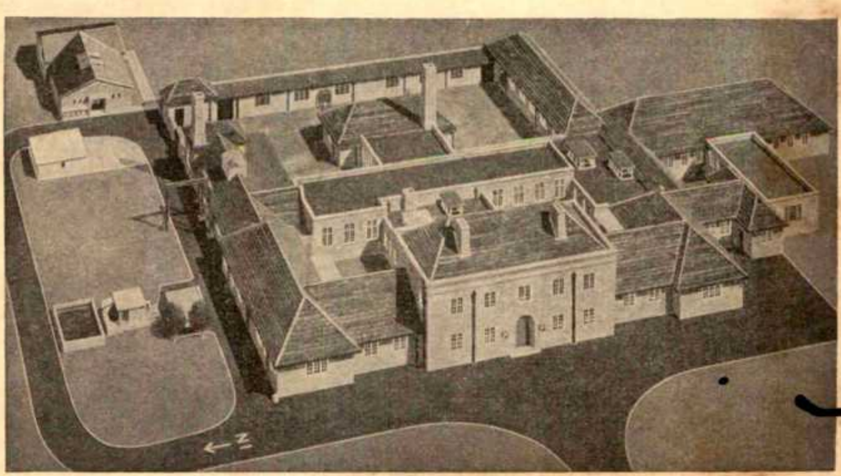


Fig. 1. Aerial view of new Laboratories of the Research Association of British Rubber Manufacturers

The new premises (Fig. 1) are near the village of Shawbury, 6½ miles north-east of Shrewsbury on the Market Drayton Road (*A* 53). Erected in 1938 by Shropshire County Council, they have a floor area of some 15,000 sq. ft. and stand on a level site of about 6½ acres. The whole building is on one floor, except for two flats over the front portion. Although built for a different purpose, the lay-out has proved surprisingly convenient for the laboratories, library, workshops and offices of the Research Association.

The laboratories proper are grouped into three categories: chemistry, physics and technology. The chemical laboratories are in two groups. In the first, the main laboratory is for analytical work, including the testing of raw materials, analysis of vulcanized rubbers, identification and estimation of synthetics, and so on, and has for this purpose many pieces of specialized apparatus. The equipment includes also a micro-balance, used in developing micro-chemical techniques applicable to rubbers and other polymers, a Spekker absorptiometer for colorimetric analyses, and an infra-red spectrometer which has been devoted particularly to the identification of organic accelerators and antioxidants in vulcanized rubbers. Other laboratories are fitted up for studies on adsorption of simple hydrocarbons on carbon black and other powders, as part of the research on the mechanism of filler reinforcement. The second group includes the main chemical research laboratory, at present devoted largely to studies on copper (and other heavy-metal) catalysis of oxidation and the development of improved sequestering agents for combating the effect of copper in promoting oxidative deterioration (ageing) of rubber.

The physics laboratories comprise two large adjacent rooms, one of which is devoted mainly to electrical measurements and has a full range of equipment for studies of volume and surface resistivity, permittivity and power factor, as well as special apparatus for testing the electrical characteristics of 'anti-static' rubber, a subject to which the Association has made important contributions. High-voltage equipment is housed in the adjoining laboratory, which also deals with studies on plasticity, using in particular the Association's 'shearing-cone plastimeter' and various other types (Fig. 2). In this room also is installed the new sinusoidal-strain dynamic testing machine constructed to designs worked out by the Association, and which will enable more complete studies of the dynamic behaviour of vulcanized rubber to be undertaken than have hitherto been possible.

The technological laboratories include the mill room, equipped with up-to-date experimental mixing plant (both open-roll and internal types) and vulcanizing equipment (platen presses and open-steam pan); and the mechanical testing laboratory, which possesses a full range of instruments for examining the physical characteristics of vulcanized rubbers—strength, extensibility, 'set' or residual deformation, hardness, resilience, resistance to tearing and to abrasion, behaviour at low temperatures, etc. (Fig. 3). These instruments, particularly those for testing hardness, include several designed by the Association or by member firms on the basis of studies by the Association. Auxiliary laboratories contain equipment for testing the resistance of rubber to repeated flexing and to the deteriorating actions of heat, oxidation, light and atmospheric ozone. This technological equipment enables the research staff to prepare experimental rubber samples under carefully controlled conditions and to assess their properties and likely behaviour during use.

In addition to these various laboratories, the premises include the library and information section, or Intelligence Division, as it is called. This contains what is believed to be the world's largest library on rubber and cognate subjects such as rubber-like plastics, together with card indexes, now totalling some 750,000 cards, on which scientific, technical and commercial information on rubber is arranged in classified order for easy reference in answering inquiries and preparing literature surveys. Offices for typing and duplicating work, a photographic dark-room, an engineering workshop, and a spacious canteen complete the layout of a research station of which the rubber industry may well feel proud.

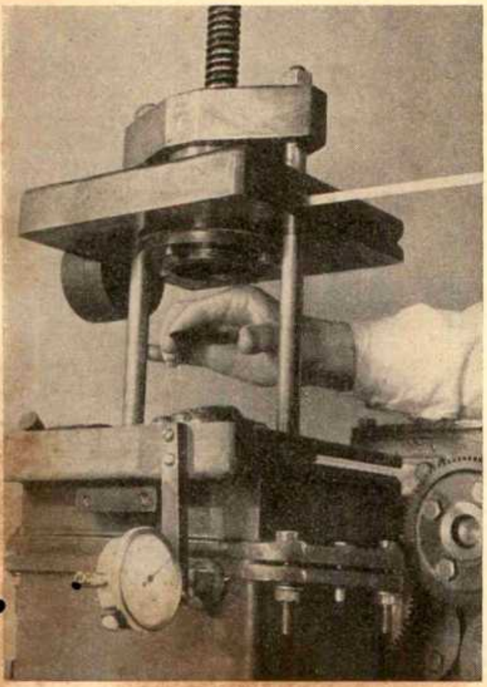


Fig. 2. Shearing-cone plastimeter for rubber

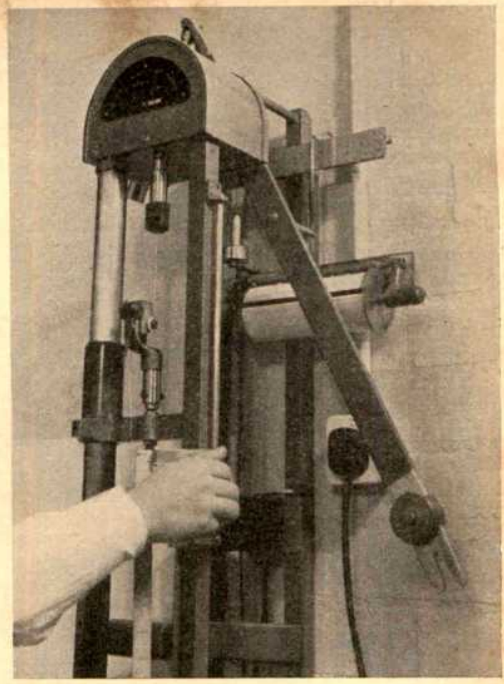


Fig. 3. Hounsfield tensile test machine, a recent British development

TREATMENT AND DISPOSAL OF SEWAGE SLUDGE

SINCE methods of treating water-borne sewage were first adopted in Britain, it has seemed obvious to many people that it should be possible to utilize profitably the plant nutrients which the liquid contains. That it is at least difficult to do this, and at the same time to dispose of the material without causing a nuisance or endangering public health, became clear during the second half of the past century when most of the sewage in inland districts was disposed of by irrigation on 'sewage farms'. For various reasons this method fell into disrepute—large areas of land were needed; land is usually expensive near towns, where most of the sewage is produced; the soil must be porous to permit irrigation at a reasonable rate; the sewage is produced continuously, but the farmer prefers to take it for irrigation only intermittently. Most sewage farms have now been replaced by modern, compact treatment plants which, at a remarkably low cost, are capable of converting sewage—often containing a large proportion of industrial wastes—into effluents which can be discharged to the small streams of Britain without serious risk to public health. The possibility of maintaining this position, but at the same time recovering further useful materials from sewage, is, however, still often raised Suggestions include using sewage effluent for irrigation, sometimes by distribution from overhead sprinklers, passing it through fish ponds, and using it as a nutrient medium for growing algae which would be harvested and dried It was because of this widespread interest in the use of urban wastes that the Natural Resources (Technical) Committee, under the chairmanship of Prof S Zuckerman, decided recently to publish the results of its study of the subject[*]

In the processes of treatment ordinarily used at a sewage works, as much insoluble material as possible is first separated by sedimentation, yielding a primary sludge containing perhaps 90–97 per cent of water The remaining liquid is then treated by a biological process to give an effluent, which is usually discharged to a stream, and a secondary sludge of high water content For every thousand persons there will be perhaps ten to twenty million gallons of effluent a year, with sludge containing twenty-five tons of dry solids

Of the inorganic nutrients present in the raw sewage, a large proportion, including most of the potash and about three-quarters of the nitrogen, is discharged with the effluent, from a thousand persons the weight of nitrogen lost annually is of the order of two tons The Natural Resources Committee recommends that methods of sewage treatment which would conserve the nutrients now lost in effluent should be investigated, so far as is known, no generally applicable methods are at present available, except that in arid countries sewage effluent is valuable for irrigation, much of its value being represented by its water content

It is much easier, however, to make use of the sludge separated at a sewage works, and indeed it is estimated that the equivalent of some 350,000 tons dry material (containing some 8,000–9,000 tons nitrogen (N), 4,000–5,000 tons phosphate (P_2O_5), and 1,000 tons potassium (K_2O)) is at present applied to the land annually in Britain as manure This is rather more than a third of the total which could be made available from the present sewered population of about 39 million persons, of the other two-thirds, part goes to sea, either in suspension where untreated sewage is discharged (as in Liverpool) or in tank steamers after separation on shore (as in London), and part is ultimately stored in tips at sewage works

The chief difficulty in disposing of sewage sludge, whether for agricultural or other uses, lies in drying it to a moisture content at which it can be transported economically and handled easily Several methods of drying are used, and it was known that the efficiency and cost of the process differed widely at different sewage works. A committee was therefore set up by the Ministry of Housing and Local Government to study the question, and it has now issued a most interesting report[†], from which the following brief notes are taken

The weight of sludge produced per thousand persons annually may range from ten tons in a rural district to more than eighty tons in an industrial one—clearly the composition of the sludge will vary equally widely The price at which partially dried sludge can be sold (per ton dry weight at the works) ranges from nothing (air-dried to 65 per cent moisture) to more than £6 (digested, 15 per cent moisture, powdered and bagged) Digestion—that is, anaerobic fermentation to yield methane and carbon dioxide—is already in use at many large sewage works, the Committee recommends the extension of the process to smaller works. Of the more mechanical drying processes, filter pressing, vacuum filtration and filtration after heating are practised at a few works, but centrifuging, though used in the United States, has not been tried in Britain A serious drawback of some of these methods is that the liquid which separates may contain a high concentration of organic matter and may add appreciably to the load on the biological stage of the sewage treatment plant An interesting and effective method of drying consists in adding a coagulant, freezing and thawing the sludge, and then filtering, large-scale plant, however, has not yet been developed, and the economics of the process are uncertain Electro-osmosis, already in use for drying soils in engineering work, appears to be inherently too expensive to use with sewage sludge

After reviewing these various methods, the committee finds in favour of the simple and unmechanical, its choice of methods being in the following order disposal in a liquid form, preferably after digestion, to manure agricultural land, digestion, and drying to 40–50 per cent moisture on beds or in lagoons, drying to 10 per cent moisture content after careful consideration of the possibilities of marketing the product, and finally—chiefly in rural areas—composting with other waste materials such as separated household refuse

This report is valuable in giving an up-to-date and balanced account of the practice of sludge treatment in Britain, it will lend little support to the theory, so often put forward, that there is in sewage sludge a large unused source of nutrient materials which could be made available to agriculture without much difficulty if only the problem were energetically attacked

OBITUARIES

Prof H Terrey

THROUGH the death on Christmas morning of Prof Henry Terrey, a loss has been sustained which will be felt in many departments of the academic life of the University of London, and in every phase of the life of University College Prof Terrey had been continuously associated with the University and with the College since 1912, successively as student, assistant, lecturer, reader and professor, and after his retirement from his University chair in September 1954 he had continued to serve the College by maintaining without interruption the discharge until the day of his death of the duties which had been his as a professor

Terrey was one of that somewhat rare species at the present time, the true-hearted inorganic chemist, though with a well-assimilated knowledge of the principles, practice, and the helpful applications of physical chemistry and a general working knowledge of organic chemistry For many years he had been the leader and mainstay of inorganic chemistry in a comprehensive chemical department in which the balance of interest between the branches has not always been easy to maintain But Terrey was of the view that the best answer to that problem was.

---

[*] The Use of Towns' Wastes in Agriculture Pp iv+25 (London H M S O, 1954) 1s 3d

[†] Ministry of Housing and Local Government Report of an Informal Working Party on the Treatment and Disposal of Sewage Sludge Pp iii+64 (London H M S O, 1954) 2s 6d net

to have no incommutable branches and no boundaries, and the breadth of his general chemical knowledge, widely outside the orbit of his personal researches in the chemistry of the rarer elements and some other special fields, as was often shown by his regular and active participation in all discussions of researches in progress, fitted him well to put such policy into practice. His specialized knowledge of the factual basis of general and inorganic chemistry was unsurpassed.

It is impossible to overstate the value of his personal qualities to the University of London and to his College. Well adjusted, friendly and wise, he was the man to whom, even when he was still a lecturer, students and professors alike turned to naturally to talk over their difficulties, knowing that they would probably come away with practical help of one kind or another, and certainly with an easier mind and a clearer course of action. He was much interested and gave much help in the organization of students' athletic activities. His personal knowledge of students throughout the years was remarkable, and for a long period he gladly gave his time to the furtherance of the affairs of the Old Students' Association of University College. His qualities cast him for the role of chairman of many boards and committees, the business of which, however contentious, he always kept on the plane of good sense and good humour. In all personal relations, his academic life was a kind of extension of his very happy home life, in which he was husband, father and grandfather. He took little, and gave much, and we who are left will gratefully revere his memory.

Mr. F. B. Stead, C.B.E.

It is with very deep regret that his former colleagues and friends learnt of the death of Mr. F. B. Stead on December 23. He was born on February 19, 1873, the son of the Ven. Samuel Stead, formerly Archdeacon of Bombay. He was a boy at Clifton College, going from there to King's College, Cambridge. At Cambridge he was placed in the first class of the Natural Sciences Tripos and left to become an assistant master at Aldenham School in 1898. In 1901 he returned, as assistant master, to his old school and remained there until 1908. He was made head of the chemistry department at Clifton College in 1908, but left soon afterwards on being appointed one of His Majesty's Inspectors of Schools, an office he occupied for the next twenty-five years, until he retired in 1933.

Stead was made staff inspector on appointment and served in Essex, Surrey and Kent. During the First World War, after being temporarily in charge of Hampshire, he transferred to the Ministry of Munitions. During 1916–18 he acted as secretary to the Prime Minister's Committee on the Teaching of Science, under the chairmanship of Sir J. J. Thomson. After the War he became a divisional inspector of education for seven years, and in 1926 was appointed chief inspector and took charge of the Secondary Branch, then responsible for the inspection of the grammar schools. He was made C.B.E. in 1931. After retirement from the inspectorate he continued for some time as an occasional inspector and even returned to full-time employment for a few months in 1940. He was chairman of the Girls' Public Day School Trust during 1944–48 and since then had been deputy chairman.

One of the most remarkable features of the educational history of Great Britain was the extremely rapid development of grammar school education during the first third of this century. In that development the Secondary Branch of His Majesty's Inspectorate, created shortly after the coming into force of the Act of 1902, played a part the importance of which has not been fully appreciated. Stead joined that Branch early in its history, and seldom was a wiser appointment made. In the first place, not only was he distinguished as a scientist, but also, even more important in view of the work to be done, he was a man of broad general culture who fully realized the dangers of early specialization which beset so many schools in that period. Secondly, sincere and forthright as he was and impatient of loose thinking and sentimental aspirations which so easily beset new developments in education, he was quick to encourage enterprises based on common sense and long and careful study of a situation. Because of this and because of his courage and unselfishness and his immediate and generous recognition of good work wherever he found it, he won the lasting respect and affection, not only of his colleagues, but also of all—administrators, governors and teachers—with whom he had to deal in his twenty-five years of public service.

NEWS and VIEWS

Electrical Engineering in the Imperial College:

Prof. A. Tustin

The appointment has been announced of Prof. Arnold Tustin to the newly created University chair of heavy electrical engineering in the Imperial College of Science and Technology, University of London. The appointment carries with it the position of head of the Department of Electrical Engineering in the College and is of especial importance in view of the plans for the expansion of the Imperial College, which have already been widely announced. Financial support has been provided for this chair from the Counterpart Aid Funds. It is intended that the chair of electrical engineering, recently vacated by Dr. Willis Jackson, shall be filled as soon as practicable by a professor of light electrical engineering within the Electrical Engineering Department of the College. Prof. Tustin, who is at present professor of electrical engineering in the University of Birmingham, is well known for his work on automatic control systems and in other fields. He has recently spent a year at the Massachusetts Institute of Technology studying the teaching of engineering, which is one of his many wide interests.

Chemical Engineering at Swansea

Prof. E. S. Sellers

Mr. E. S. Sellers, whose appointment to the newly established chair of chemical engineering in the University College of Swansea has recently been announced, is a graduate of the University of London.

He was first employed in the Lancashire textiles industry and later by the then Anglo-Iranian Oil Co. at Abadan Mr Sellers returned to Great Britain in 1938 and joined the staff of the Manchester Oil Refinery, Ltd, and was its refinery superintendent at the time of his appointment in 1948 to a University lectureship in the then newly established Department of Chemical Engineering at Cambridge Mr Sellers had previously had some experience of teaching as a part-time lecturer at the College of Technology, Manchester, and from the start was able to play a large part in the planning of the courses and the general organization of the Cambridge School. His research interests have been mainly in the field of distillation processes, including processes operating at very low temperatures Mr Sellers has been an active member of the Institution of Chemical Engineers, being on both its Board of Examiners and its Education Committee He has also been much interested in furthering the co-operation of industry with universities in matters of education, and in the past few years has run two successful 'practice school' courses, first at the Stanlow Refinery of the Shell Refining and Marketing Co, Ltd, and secondly at the Royal Ordnance Factory, Bridgwater It is expected that he will take up his new duties at Swansea next October

Geological Society Awards for 1955

THE Council of the Geological Society has made the following awards for 1955 *Wollaston Medal* to Sir Arthur Trueman for his outstanding and varied contributions to palæontology and stratigraphy and in particular for his palæontological work on the non-marine lamellibranchs of the Coal Measures, this latter work has initiated and led to fundamental advances in palæontology and to the rationalization of British Coal Measures geology, *Murchison Medal* to Dr C J Stubblefield in recognition of his valuable contributions to palæontology and for his work on palæozoic stratigraphy, *Lyell Medal* to Mr W N. Edwards, keeper of geology in the British Museum (Natural History), in recognition of his distinguished work in the palæobotanical field, *Bigsby Medal* to Dr P E Kent for his contributions to the palæogeography and stratigraphy of England and Wales and his researches in Central Africa and Persia, *Wollaston Fund* to Mr J M Edmonds for his contributions to the history of geology and the geology of the Oxford district, *Murchison Fund* to Mr R Casey for his illuminating work on the Aptian and Albian strata of southern England, a moiety of the *Lyell Fund* to Dr P A Sabine for his petrological work, especially in the Assynt area of Scotland, another moiety of the *Lyell Fund* to Dr W Bullerwell for his work in applied geophysics and in particular for his contributions to the gravimetric survey of Great Britain

Royal Astronomical Society Awards

THE following medal awards of the Royal Astronomical Society have been made *Gold Medal,* Prof Dirk Brouwer, director of the Yale University Observatory, for his outstanding contributions to celestial mechanics, *Eddington Medal,* Prof H C van de Hulst, of the Observatory, Leyden, for his prediction of the 21-cm line radiation of neutral hydrogen, and for his share in its detection and observation and in the theoretical interpretation of the observations.

Some Exhibits in the Cavendish Laboratory Museum

AN illustrated account of some of the instruments made by Elliott Brothers, Ltd, which are in the Museum of the Cavendish Laboratory, Cambridge, has appeared in the *Elliott Journal* (2, No. 1, 1954). In an earlier article in the same journal (1, No. 1, 1951) reference was made to some of the apparatus constructed for Maxwell, Rayleigh and others by the firm, but a recent rearrangement of the apparatus in the Museum has suggested a fuller account of the more notable Elliott instruments collected there Maxwell's colour top and his real-image stereoscope are described, and some interesting details are given of his experiments and results using the well-known disk apparatus for the determination of the viscosity of gases, which was constructed for him by Mr Becker and described in Maxwell's Bakerian Lecture to the Royal Society on February 8, 1866 Maxwell was succeeded as Cavendish professor by Lord Rayleigh, whose research was concentrated on the provision and maintenance of high-precision electrical standards Elliott Brothers made some of the earliest sub-standard resistance boxes calibrated in terms of the British Association ohm, and later assisted in the re-determination of the ohm by Lord Rayleigh and Mrs Sidgwick by constructing the well-known spinning-coil apparatus used in that series of experiments A photograph of the apparatus and references to the original papers are included in the article.

Geological Background of the Iyatayet Site, Alaska

IN 1951 Giddings published his discovery of a blade, core and burin industry, which he called the Denbigh flint complex This preceded and differed fundamentally from the known Eskimo occupations of Alaska, including the palæo-Eskimo one of which Ipiutak is a part, and its importance is due not only to its age but also to its possible Upper Palæolithic ancestry A description of the recent geology of the site of the discovery, with an attempt to correlate it with recent deposits elsewhere in Alaska, has been published as a paper by D M Hopkins and J L Giddings, jun, in Vol 119, No 2 of the Smithsonian Miscellaneous Collections (Pub 4110. Pp ii+33+4 plates Washington, D C. Smithsonian Institution, 1953) On archæological grounds, the authors believe that the industry is older than the related one, lacking burins, found at Trail Creek, Seward Peninsula, and dated by radiocarbon at about 4000 B C Two alternative correlations are suggested one would give the Denbigh industry an age greater than 10,000 B C, and the other, which the authors prefer, would date it at about 6500 B C. The paper illustrates the specialized knowledge required for the interpretation of Quaternary geology in these regions, since it includes such unexpected features as the correlation of forty feet of aggradation in a valley with a period of low rather than high sea-level.

Nitrogen Metabolism of Ripening Fruit

IN a recent study of the nitrogen metabolism of apple fruits, A. C Hulme (*J Exp. Bot*, 5, No 14, 159, 1954) has found that a close parallelism occurs in the trend of respiration-rate and the ratio protein nitrogen/non-protein nitrogen, both in attached fr[illegible] and in fruits harvested at various stages of development and stored for several months at 12° C. In detached fruits the fall in respiration which occurs immediately after picking is only accompanied by a concomitant fall in net protein in very young fruits in which active cell-division is taking place Afterwards, in fruit of all ages, when a climacteric rise in respiration occurs, it is accompanied by a net increase in protein It is argued that the climacteric rise in respiration is a result of increase in the level of protein which will be expected to reduce the adenosine triphosphate/diphosphate ratio Over the climacteric period, although rate of respiration and net protein content both rise, the former rises more rapidly than the latter and, afterwards, falls at a faster rate than the protein content It is suggested that this may be due to the 'new' protein containing a higher proportion of enzyme(s) directly involved in respiration and leading, for example, to a reduction in the adenosine triphosphate/diphosphate ratio

Ophioglossum Organization in Embryos and Induced Buds Compared

When the sequence and rate of organ formation in embryos and induced buds of *Ophioglossum vulgatum* are compared, some interesting results emerge (C W Wardlaw, *Ann Bot*, 18, 72, 397, 1954) In the embryo, the appearance of the primary root considerably precedes the organization of the shoot apex and the formation of the first leaf, but in induced root and shoot buds the reverse is the case With the limited nutrition provided by the saprophytic underground prothallus, the first leaf of the embryo (actually the second leaf formed) does not appear above ground until after seven to eight years, but in buds induced in decapitated shoots, four to six new leaves may be formed in five to six months Completely defoliated shoots may show a comparable rate of leaf formation. The conclusion is reached that while the fundamental pattern of development is the same in embryos and buds, the actual sequence in which the primary organs are formed, and their rate of formation and development, are referable to nutritional factors

Zoological Nomenclature

As from June 30, 1955, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of the plenary powers for the purpose specified against each entry Full particulars were published on December 30, 1954, in Parts 10 and 11 of Vol 9 of the *Bulletin of Zoological Nomenclature* (1) *Dama* Frisch, 1775 (Cl Mammalia), validation of, for use for the name for the fallow deer of Europe, (2) *Helicella* Férussac, 1821 (Cl Gastropoda), validation of, (3) *rufa* Linnæus, 1761 (*Formica*), validation of, and designation as type species of *Formica* Linnæus, 1758 (Cl Insecta, Order Hymenoptera), (4) *Carnifex* Binney, 1865 (Cl Gastropoda), validation of, (5) *Discias* Rathbun, 1902, *Upogebia* Leach, 1814, *Processa* Leach, 1815, Xanthinae Dana, 1851, Upogebiinae Borradaile, 1903, and Processidae Ortmann, 1896 (Cl Crustacea, Order Decapoda), validation of Comments on these cases should be sent as soon as possible to Francis Hemming, secretary to the Commission, 28 Park Village East, Regent's Park, London, N W 1

Group Discussion

Over recent years the Central Council for Health Education (Tavistock House, Tavistock Square, London, W C 1) has published a number of articles in its quarterly journal dealing with various aspects of group discussion in educational, social and working life These evoked considerable interest and, as a result, the Council has brought them together and published them in book form They include accounts of the theory and practice of group discussion by Dr M L Johnson, preparation for a group discussion by Dr Emrys Davies, the technique of running discussion groups by M Fassam, how to run meetings by J J Gillespie and Dr J Burton, discussion in a secondary school by Frank Tyrer, the Quaker group by B Pollard, and group psychotherapy by Dr E J Anthony There is also a detailed and comprehensive bibliography

Economic Developments in Mexico

The main article in the autumn issue of *Progress*, the magazine of Unilever, Ltd, describes economic developments in Mexico It has been contributed by Dr Eduordo Villasenor, formerly director-general of the Bank of Mexico, who shows that, despite all the difficulties thrown up by the geography of the country, agrarian reform and industrialization are increasing rapidly and are being accompanied by many developments in education and welfare services Mexicans are particularly proud that their State University, which is the oldest on the American continent, now possesses the "most modern buildings and equipment of any university in the world"

Documentation in Aeronautics

At the fourth meeting of the Documentation Committee of the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization in Paris during November 2–6, closer liaison was recommended between the documentation committee and the technical panels of the Group, and in particular it was suggested that the committee might assist the panels in the preparation of bibliographies Progress was reported in the preparation of the interlingual aeronautical dictionary A French version of the British Standards Institution's glossary of aeronautical terms was ready for circulation for criticism, a German translation would be ready for revision shortly, Part 1 of a Dutch translation was ready for circulation, and Part 1 of a Russian translation had been revised It was agreed to produce first individual volumes for each language, with an alphabetical index, for limited circulation in the country concerned for criticism, and not to undertake the preparation of the complete dictionary until criticisms had been received and amendments made It was also agreed to maintain contact with Dr Heflin's project for a dictionary of Air Force language

A sub-committee was appointed to review critically the production of an international abstract bulletin and, if possible, to recommend an alternative approach to the improvement of abstracting services Subject classification schemes used in aeronautics were also discussed as well as methods of retrieving punched cards, and it was recommended that, in co-operation with Unesco, a list of systems, covering the mechanics as well as methods of coding, now in use in aeronautical fields should be made Recommendations made at the previous meeting in favour of improving the availability of classified reports were confirmed and a suggestion for the preparation of a guide to the sources of aeronautical information was welcomed It was also agreed that the adequacy of the translation coverage of aeronautical literature requires close examination, and a draft report is to be prepared for the next meeting

Recent Developments in Radio Astronomy

A recent issue of "Occasional Notes of the Royal Astronomical Society" (3, No. 16; 1954) is entirely devoted to the subject of radio astronomy and is made up of ten papers by Prof. A. C. B. Lovell and his colleagues at the Jodrell Bank Experimental Station of the University of Manchester. A short introduction by Prof. Lovell is followed by two chapters dealing with radio telescopes and techniques, copiously illustrated by plates and a number of diagrams. In these the main principles underlying the use of radio telescopes are explained, and the first chapter ends with a short account of two modern instruments: the large interferometer recently brought into use in Cambridge by M. Ryle; and the pencil-beam radio telescope under construction at Jodrell Bank, which, it is hoped, will be in use in 1955. After this, the remaining eight chapters deal with the application of radio astronomy and are arranged in order of distances from the earth as follows: meteors; radio echoes from the aurora and the moon; radio waves from the sun; radio waves from the galaxy; the identification of the radio stars; the scintillation of the radio stars; radio waves from the interstellar hydrogen; radio waves of extragalactic origin. These provide adequate information for general readers interested in radio astronomy and are well illustrated (there are seven plates and twenty-seven diagrams altogether in the issue), and those who desire more extensive details will find in the bibliography a list of publications during the past eight years, several of which appeared in 1953 and 1954. Two points merit comment here. The first is that the origin of scintillations is not in the source itself but is due to varying atmospheric conditions; and, while these scintillations are very inconvenient to the radio astronomer, they provide a new technique to the geophysicist for investigating the complexities of the upper regions of the earth's atmosphere into which exploring rockets have not yet penetrated. The other is that among the normal nebulæ there may be distributed a class of nebulæ which are more powerful emitters than the normal spirals. It is difficult to say what peculiar property this class possesses, but there is support from different sources for the above suggestion, among which may be noticed the identification by Stanley and Slee of the intense sources in Virgo and Centaurus with the peculiar nebulæ NGC 4486 and NGC 5128, and the more recent identification of the intense source Cygnus 1 with two faint extra-galactic nebulæ in collision. Other lines of evidence also support the suggestion.

Exchange of Students for Technical Experience

The remarkable increase in the number of technical students who obtain practical experience in other countries during their long vacations is shown in the seventh annual report of the International Association for the Exchange of Students for Technical Experience. During 1954 the number of effective exchanges made has been 4,267 students, showing a further increase of 484 over the 1953 total. In addition, 148 students were placed between Turkey and member countries of the Association. Portugal was admitted to the Association in January 1954, and India and Turkey have made application for admission. Difficulties are being encountered in the United States in forming a central committee for the exchange of students, although many industries have signified their readiness to receive students, and the U.S. State Department has expressed willingness to facilitate the admission of students by the allocation of the necessary programme number to cover the issue of visas for visiting overseas students.

University of London: Appointments

The following appointments in the University of London have been announced: Dr. A. W. Skempton, reader in soil mechanics at the Imperial College of Science and Technology, to the University chair of soil mechanics tenable at that College; Dr. D. G. Harvey to the University readership in chemical pathology tenable at the Royal Veterinary College; Prof. Norman Millott, professor of zoology in the University College of the West Indies, to the University chair of zoology tenable at Bedford College in succession to Prof. H. Munro Fox.

Announcements

The 1955 James Watt International Medal of the Institution of Mechanical Engineers has been awarded to Dr. Igor Ivan Sikorsky, in recognition of his life's work in applying science to the progress of mechanical engineering through pioneering development of aircraft of various types—multi-engined, amphibians and particularly helicopters. The James Watt International Medal was founded to commemorate the bi-centenary of the birth of James Watt on January 19, 1736, and is the Institution's highest award.

On the occasion of the Fourth World Petroleum Congress to be held in Rome during June 6–15, an International Oil Equipment Exhibition will be organized in Naples, in the premises of the Overseas Fair (Mostra d'Oltremare). This Exhibition will remain open during June 5–20.

The group of European molecular spectroscopists, which held meetings at Basel in 1951 and Paris in 1953, has arranged to hold another meeting in Oxford during July 7–11, 1955. The subjects discussed will cover a wide range of ultra-violet, infrared and Raman work. Further information may be obtained from Dr. H. W. Thompson, St. John's College, Oxford.

A conference on "The Functions and Education of the Chemical Engineer in Europe", organized by the Institution of Chemical Engineers in co-operation with the Department of Scientific and Industrial Research for the European Productivity Agency of the Organization for European Economic Co-operation, will be held at Church House, Westminster, London, S.W.1, during March 21–23. Eleven Western European countries are expected to take part. The conference is open to official delegates and members of the Institution of Chemical Engineers. Further information can be obtained from the Institution, 56 Victoria Street, London, S.W.1.

The third annual meeting of the editorial board of the *Journal of Embryology and Experimental Morphology* will be accompanied by a conference on embryology to be held in the Palais des Académies and the Faculté de Médecine in Brussels during April 4–7. Those wishing to attend are asked to inform Prof. A. M. Dalcq, 97 rue aux Laines, Brussels, as soon as possible. (Those travelling from Britain should communicate instead with Dr. D. R. Newth, Department of Zoology, University College, London.) Requests for accommodation in Brussels must be made before February 1.

GENEVA LABORATORY OF THE BATTELLE MEMORIAL INSTITUTE

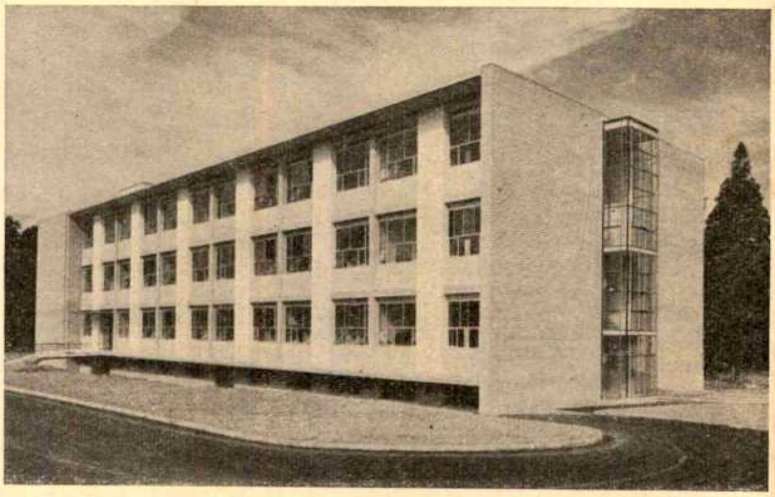
By FRANK C. CROXTON

Assistant Director in Charge of Operations in Europe, Battelle Institute

ON November 26 the Geneva Laboratory of the Battelle Memorial Institute was formally opened before an assembly of three hundred guests from five countries. M. Denis de Rougemont, author and director of the European Cultural Centre, gave an address in which he first explored the reasons for research, described by him as a spiritual passion. After reviewing the need for research, he discussed its purpose, which is the liberation of man by reducing his labours, and said that it is in the creative spirit that research institutes, especially Battelle, must work. Prof. G. Colonnetti, president of the Italian National Research Council, spoke of the benefits to be derived in future years from the peaceful applications of nuclear energy. He reminded his listeners that machines have not caused unemployment but that, on the other hand, man is not yet master of the machine to the extent that he is called on for his intelligence rather than his muscles. He doubted the value of research if the results are applied without concern for their effect on society. Prof. L. Jacqué, professor of chemistry in the École Polytechnique, Paris, described the participation of French scientific workers in the important technical developments of the world and continued by reviewing some of the notable chemical discoveries of recent times. He spoke of several of the research institutions working for the advancement of science and technology and referred especially to organizations such as Battelle and the services that they can render.

The Battelle Laboratory at Geneva is one of three which, with a marine research station in Florida, constitute the Institute's experimental facilities. In addition to its main offices at the Columbus Laboratory and also laboratories at Frankfurt am Main, it also has offices in London, Madrid, Milan and Paris. The Battelle Institute was founded by the bequest of Gordon Battelle, and research was begun in 1929, so that 1954 marks its silver jubilee year. Its intention during this time has been to provide research services of a very practical sort, designed to fit the needs of industry. Although its beginnings were in metallurgy and fuels, the Institute was requested to enter many allied fields, until now it can be said to carry out research and development programmes in essentially all fields of technology. The Institute was originally pictured as of local significance; but as it grew it was soon serving industries from all parts of the United States as well as those of several other countries. It became apparent that Battelle's research services should be made available more generally, and so laboratories were constructed at [redacted]kfurt and now at Geneva. It is doubtful whether Gordon Battelle envisaged the expansion of the contract-research concept to an international scope; but his original ideas of providing research services to industry and thus to mankind have been fully implemented by this step.

The perfectly rectangular building of the new Geneva Laboratory consists of three stories and basement and is situated on a 22-acre plot of land in Carouge, a suburb of Geneva; with it are a villa and a farm building. Immediately after its reconstruction, it was necessary to use the villa for housing the essential requirements; but now it is used for the administrative offices, library and the telephone exchange. The farm building contains the machine shop, carpentry shop and garage. At the earliest possible moment the laboratory building was begun. It was completed only a few weeks before the official opening, but was quickly occupied by the technical staff and their apparatus. This building has a floor area of forty thousand square feet. At one end, the pilot-plant laboratory extends from the ground-floor level to the roof, a height of about thirty-two feet, which permits the installation of tall distillation or extraction columns. The auxiliary apparatus can be placed on the ground floor and on balconies at each of the higher floor-levels. The general laboratories are built on a modular basis. Partitions between them are of non-load-bearing construction to permit removal when necessary for alterations. Hot and cold water, gas and air are available for each unit, as are ducts for hoods where necessary. Both the Geneva and Frankfurt Laboratories use the bus-bar duct system of power distribution which provides the flexibility so frequently needed in a research building. The painted concrete floors are economical but clean, and lighting is at a high level to increase efficiency and accuracy. The stairways are constructed in a rather novel manner permitting each flight to be lifted aside, thus leaving a completely open stairwell for the hoisting of heavy equipment; in addition, there is a combination freight and passenger lift.



Battelle Laboratory at Carouge–Geneva

The Battelle Institute undertakes research for the sole benefit of each client and hands over all results, including patents, the work being carried out on a completely confidential basis. At Geneva, research is being done in physics, chemistry and metallurgy by the staff of eighty-five people. Serious consideration is given to new fields of research as industry demands them, so that, like the Columbus and Frankfurt Laboratories, the Geneva Laboratory is a dynamic rather than a static organization. Each project receives the full attention of the Institute's entire research facilities in the United States and Europe. The volume of research already achieved makes it evident that the Battelle Institute can be as helpful in Europe as it has been in the country of its origin.

THE COLOMBO PLAN: TECHNICAL CO-OPERATION SCHEME

UNDER the Technical Co-operation Scheme of the Colombo Plan, which completed its fourth year in June 1954 (The Colombo Plan. Technical Co-operation Scheme. Report for 1953–54 by the Council for Technical Co-operation in South and South-East Asia. Colombo, July 1954. London: H.M.S.O., 1954. 1*s* net), training was arranged in 1953 for 608 persons as against 538 in 1952, and 1,653 places have now been provided in all, mostly for graduates with a background of experience which enables them to benefit from their specialist training abroad in various fields of economic development. By June 30, 1954, the largest group (268) went abroad for training in food and agriculture; of the others, training in government administration claimed 266, engineering 192, medicine and health 168, education 135, transport and communications 132, industry and trade 131, and power and fuel 123. The United Kingdom provided facilities for 638 trainees, including 211 from India, 195 from Ceylon and 157 from Pakistan. Of Australia's 487 trainees, 116 came from India, 91 from Pakistan, 80 from Indonesia and 79 from Ceylon. Canada has taken 210 trainees (93 from Pakistan and 92 from India), New Zealand, 170 (45 from Ceylon, 39 from Malaya, 35 from India and 32 from Pakistan), while India has taken 137 trainees, including 67 from Ceylon and 23 from Pakistan. The figures indicate that while Pakistan and Indonesia are concentrating on training in administration, India and Ceylon are concentrating on training facilities in food and agriculture.

The demand for experts has been heaviest in the field of medicine and health. The 58 experts provided in 1953 (compared with 90 in 1952 and 45 in 1951) brought the total provided to 263 as against 502 applied for; and of these, 69 are in medicine and health, 36 in transport and communication, 33 in engineering, 33 in food, agriculture and forestry, 25 in education and 23 in industry and trade. Of the 115 experts provided by the United Kingdom, both India and Ceylon took fifty. Of 45 supplied by Canada, 22 went to Ceylon, 10 to Pakistan and 9 to Malaya. Of New Zealand's 30 experts, 12 went to Pakistan. Although 239 requests were outstanding, offers are still awaited against only 133.

Requests for equipment for use by experts or for training and research institutions since the beginning of the Scheme have totalled £1·5 million, against which equipment to the value of £1 million has been supplied or offered. Requests totalling £714,500 have been received from Pakistan, £591,700 from India and £171,000 from Ceylon. Equipment supplied or agreed in principle by the United Kingdom includes £14,000 worth for the Technical High School, Karachi, and £155,000 for nine new technical high-schools in Pakistan, £50,000 worth for the Mercantile Marine Academy, Pakistan, and £82,000 for the Pakistan Department of Scientific and Industrial Research, £139,000 for the Textile Training Centre, Lyallpur, £70,000 for the National Metallurgical Laboratory, Jamshedpur, £24,000 for the Central Testing and Standards Laboratories at Karachi and Dacca, £37,500 for the Central Water Power, Irrigation and Navigation Research Station, Poona, £12,380 for the Bengal Engineering College, Calcutta, £18,300 for the Research Laboratory of the Forest and Education Branch of the Ceylon Forest Department, £25,000 for the Central Science Teaching Centre, Bandung, and Teacher Training Centres at Djogjakarta and Surabaya.

BIOLOGY AND A GENERAL UNIVERSITY EDUCATION

A CONFERENCE on "Biology and a General University Education", organized by the Institute of Biology, was held at the University College of North Staffordshire, Keele, on December 20–21. Most of those attending were paying their first visit to Keele, and it was clear from what was said at dinner-table and in common rooms that they generally liked what they saw and heard of the College. There was appreciation, too, of the inclusion in the general education for which North Staffordshire stands, not only of biology but also of those traditional academic graces which are so conspicuously lacking in some of the universities born of the industrial revolution.

In the first session, under the chairmanship of Prof. S. Zuckerman, three speakers described biology courses for arts students that are already in existence. Prof. A. R. Gemmell dealt with biology as one alternative for the compulsory natural science subject for students of the humanities or social sciences at Keele. He tries to give his students an insight into the scientist's approach and some knowledge of the nature of laboratory work, to relate the science to the student's own background of knowledge, and to stimulate him to think. The centre of the course is man, and there are fifty-two lectures, on mammalian physiology and anatomy, parasitism and disease, genetics and agriculture. There is a three-hour practical class each week, including dissection of the rabbit and some work with *Drosophila*. Dr. J. Hutchens (Chicago) then described biology as a part of the general education course at his university. Here physical science is studied as well, and before biology, and the students include those who will later specialize in sciences as well as the humanities. The emphasis in the biology course is on the physiology of man; but the laboratory course begins with microscopy—pond water, blood cells and so on—a practice of which Dr. Hutchens does not ap[illegible]. There are differences of approach in different parts of the course, some stressing details and others general principles. For the most part, the teaching in general education is done by a separate staff from that of the divisions which deal with higher degrees; this frees research workers whose chief interest is the multiplication of published papers from work which will not lead to their academic advancement, but has the unfortunate effect of making the others, whose job is teaching rather than research, feel somewhat second-class.

Dr C Gordon dealt with a course in social biology which he gives to social science students at Edinburgh; this is complementary to one in anatomy and physiology given by a physician. The biology is academic and vocational and includes topics such as man's place in the animal kingdom, the effects of heredity and environment, and some discussion of physiology and vital statistics. The students take an examination at the end of the course, and their answers are on the whole well written but show no evidence of any ability to interpret data. This is partly because the students are frightened of mathematics, but may also be due to the absence of any practical work, which the scientists have not yet been able to induce the board of studies to impose.

In the subsequent discussion, a number of speakers said that they could give a better education if they had students for four years instead of three; but there was no general agreement on the meaning of a fourth year or on what to do with it. For some, it seemed to mean ignoring what the students had done at school or teaching them again what they had already had the opportunity of learning there; for others it meant the possibility of lengthening and strengthening the course for an honours degree. The sense of the meeting was probably that it is a good thing to have a specialist staff to teach science to arts students; but that its members should also take part in straightforward research, and that some form of practical work is desirable.

In the afternoon Prof Gemmell took the chair, and the conference heard three professors at North Staffordshire say how useful his biology course was for their students. Prof. S Finer (social science) found its advantage to be that it taught them the background of knowledge of human ecology necessary for their practical work; Prof. W C. Stewart (education) welcomed it for its aid in the understanding of child development; and Prof J. Blake (history) liked its broadening of outlook and its development of a different aspect of truth from those with which the historian and philosopher deal. In the absence through illness of Mr. L J F Brimble, Mr W B. Yapp (Birmingham) gave the only other set paper in this session, which had the title "Biology for Arts Students—Is it worthwhile ?" He suggested that in order for such courses to be justified, there had to be a successful solution of the problem of language, careful selection of topics which are wide in scope but deep in the demands which they make on the students' understanding, and even more careful selection of the teacher. Referring to the theory of organic evolution as probably the best single topic, both on theoretical grounds and in practice, he said that those who taught it to arts students should have a wide background of knowledge and in particular ought to have read "The Origin of Species". This divided the audience, or at least the vocal part of it, fairly evenly into those who had read the book and agreed with the speaker, and those who had not and thought it unnecessary to do so. In the rest of the discussion Prof T. A Bennet-Clark (King's College, London) voiced the disappointment of many of the biologists when he said that the three Keele speakers had all spoken chiefly of the value of biology on vocational grounds.

The final session, with Prof O. E Lowenstein in the chair, was on "Biology in a General Science Education". Prof Bennet-Clark defended it as suitable for third-class and pass-degree men who would enter commerce, and felt that a training in science gives a better education, in A N Whitehead's sense of "a habitual vision of greatness", than is now possible for the humanities. Prof F W R. Brambell (Bangor) put the case against general science by arguing for the virtues of specialization on educational grounds. He recommended opportunism in the choice of advanced courses, and the pursuit of them to the forefront of knowledge according to the interests of the staff available. Among points raised in the general discussion were the difficulty that early study of the basic sciences often lays down special interests at school (Dr Gordon), the need for courses not leading to a professional career in biology (Dr. Hutchens), the advantage of an encyclopædic knowledge (Prof Lowenstein), the importance of knowing when one is ignorant (Mrs Riddiford), and the value of a biological training in teaching one to deal with complex situations. There seemed in the end to be a greater measure of agreement between the two principal speakers than at first appeared. Both wanted as much specialization as possible for those who could profit from it, and both held that biology had more to offer than its mere vocational value for those who would use it in after life. One of the most pleasing aspects of the conference was the general feeling that a university training in biology can be one of the best preparations for entry to those careers in administration and leadership for which we have not yet designed precise undergraduate courses. Biology, in fact, might well take part of the place so long occupied by the classics but for which they are no longer fitted. One would like to see a full and reasoned statement of this view, which was implicit rather than openly said in much that passed at the conference.

W. B. YAPP

GASEOUS ELECTRONICS

CONFERENCE IN NEW YORK

THE Gaseous Electronics Conference has now become an annual meeting in the United States which is greatly looked forward to by all those interested in the subject. The 1954 Conference was sponsored by the Division of Electron Physics of the American Physical Society, and the host institution was the College of Engineering of New York University, which is celebrating its centenary. The meetings were held in New York City during October 14–16, and were attended by about 240 members from all over the United States and Canada. More than a third of the forty-five papers (forty-one contributed and four invited) came from universities, the rest coming from the great industrial laboratories and government establishments, representing in all twenty-seven different organizations. Members of the Conference were entertained at a banquet at which the guest speakers were Dr. T E. Allibone, of Associated Electrical Industries, Aldermaston, who described current work in England on gaseous electronics, and Dr W. Finkelnburg, of Siemens-Schuckert, Erlangen, who described present-day

German work in this field. The chairman of the Committee of the Conference was Dr. W. P. Allis, of the Massachusetts Institute of Technology, and Dr. L. H. Fisher, of New York University, as secretary, was responsible for the excellent Conference arrangements.

A very wide field was covered in the papers and it is not possible in this brief report to describe the material in any detail: their subject-matters ranged from atomic cross-sections to the properties of complicated statistical assemblies such as the high-temperature arc. Of late years much work has been done in improving modern vacuum techniques and in the preparation of pure gases and of clean surfaces, and this has led to the re-evaluation of some fundamental ionization and collision data. Among such papers were those of W. H. Hickman and R. E. Fox (Westinghouse) on negative-ion formation using low (0·1-eV.) mono-energetic electrons, the narrow capture process yielding information about the behaviour of such electron beams, and that of E. Gerjuoy (Pittsburg) and S. Stein (Westinghouse) discussing theoretical work on rotational excitations by slow electrons. L. M. Branscomb (Bureau of Standards) described measurements of the photo-detachment cross-section for the hydrogen atom, obtaining a result within 10 per cent of that calculated by Chandrasekhar. N. Wainfan, W. C. Walker and G. L. Weissler (Southern California) reported determinations of cross-sections for photo-ionization of carbon dioxide, argon and the hydrogen and water molecules in the wave-length range 473–1100 A., and of photoelectric yields in the vacuum ultra-violet. The atomic absorption cross-section of atomic nitrogen found by A. W. Ehler and G. L. Weissler agrees with that calculated by Bates. D. J. Rose (Bell Laboratories) reported recent determinations of Townsend's α in hydrogen over the range $20 < Z/p < 1{,}000$ V./cm. mm. mercury, assessing disagreements between previous determinations. H. D. Hagstrum (Bell Laboratories) described determinations of the secondary emission of electrons from surfaces either atomically clean or contaminated by a monomolecular gas layer. With clean surfaces $\gamma_{\max}$ for He$^+$ is found to be $\sim 0{\cdot}2$ and largely independent of ion energy; but for contaminated surfaces γ increases with ion energy and may become as high as unity. F. Keywell (Bell Laboratories) discussed high-vacuum sputtering. R. N. Varney (Washington) reported work on diffusion, and A. V. Phelps (Westinghouse) described the diffusion and volume-loss coefficients of helium metastable atoms and molecules; and the life-time of metastable mercury molecules was discussed by C. G. Matland and A. O. McCoubrey (Westinghouse).

Another group of papers dealt with the physics of plasma. Plasma oscillations were considered by J. E. Drummond and L. Wilcox (Sylvania); fluctuations in crossed electric and magnetic fields by H. W. Batten (Michigan); travelling striations by N. L. Oleson (U.S. Naval Postgraduate School); noise mechanism by M. I. Skolnik (Johns Hopkins); aspects of plasma resonance by K. S. W. Champion and S. C. Brown, and a microwave study of positive ion collection using probes by G. J. Schulz and S. C. Brown (Massachusetts Institute of Technology); cumulative ionization processes in the helium positive column by L. S. Frost and A. V. Phelps (Westinghouse).

A number of papers dealt with properties of the electric arc. Low-voltage phenomena were discussed by E. O. Johnson (R.C.A.) and extreme temperature phenomena by W. Finkelnburg (Siemens-Schukert). Other aspects of discharge phenomena were described in a session which included an invited paper by H. Margenau (Yale) on the effect of electrons on spectral lines emitted in a discharge, and papers on the cathode spot arc by Robert St. John, J. G. Winans (Wisconsin) and by C. G. Smith (Raytheon). D.C. arcs in a magnetic field were discussed by L. P. Winsor (Rensslaer) and T. H. Lee (General Electric), and R. W. Warren (California) reported measurements of electric fields in glow discharges.

A third of the programme was devoted to papers on electrical breakdown, and, in particular, to the ionization processes by which the ionization builds up on the application of electric fields.

Variation of mean free paths in discharges was considered by I. A. MacLennan and A. D. MacDonald (Dalhousie). Two papers on the influence of field emission on Paschen's law at high pressure and in vacuum phenomena breakdown were given by L. H. Germer, P. Kisliuk and W. S. Boyle (Bell Laboratories). The influence of molecular structure on the sparking potential of hydrocarbon gases was discussed by R. W. Crowe and J. C. Devins (General Electric). A paper by E. L. Huber (California) described work on corona breakdown in nitrogen and oxygen and mixtures, using α-particle triggering. Further experimental evidence on the development of a Townsend avalanche preceding breakdown was given by H. W. Bandel (California) for air, and for argon by M. Menes (Westinghouse), who suggested a process involving delayed photon emission. A session was devoted to a symposium of three invited papers on breakdown. A paper on the mechanism of uniform field static breakdown was given by F. Llewellyn Jones (Swansea, Wales), a paper on the formative time-lags of uniform field breakdown by L. H. Fisher (New York), and a paper on secondary processes and the mechanisms of spark breakdown by L. B. Loeb (California). The ensuing discussion indicated a general agreement on the role taken by the electron avalanche and the secondary ionization processes, and, while helping to clarify terminology, also indicated the field that still awaits complete quantitative explanation—as that of the complete build-up to a high current-density spark-channel after the applied voltage had attained or exceeded the static breakdown potential.

Miscellaneous subjects were dealt with in papers by C. Kenty (General Electric) on metallic flames excited by active nitrogen, by H. P. Broida (National Bureau of Standards) on afterglow of solid nitrogen, and by W. M. Brubaker (Consolidated Engineering Corp.) on space charges in mass-spectrometer ion sources. Probes for space-charge fields were discussed by P. Coopermann (Research Corporation), electronic tuning of microwave cavities by F. R. Arams and H. K. Jenny (R.C.A.), ionization in long nitrogen afterglows by W. B. Kunkel and A. L. Gardner (California), and studies of anode pre-breakdown phenomena in thyratrons were described by S. Goldberg (Edgerton, Germeshausen and Grier, Inc.). Fire-ball discharges were discussed by G. Medicus (Wright Air Development Center) and by K. G. Henquist and E. O. Johnson (R.C.A.).

In closing the Conference, Dr. W. P. Allis mentioned that the general subject for the conference to be held next year will be discharge phenomena at extremely high temperatures.

F. Llewellyn Jones

PRODUCTION OF TOWN GAS BY GASIFICATION PROCESSES

ON September 3 at the recent British Association meeting in Oxford, Dr F J Dent, director of the Gas Council's Birmingham Research Station, read a paper to Section B (Chemistry) on the gasification of coal He began by pointing out that town gas has most of the properties of an ideal fuel, being smokeless, clean, convenient and amenable to precise control Its use has increased steadily, until now the heat units distributed as gas are equal to 6 per cent of those in the total coal mined, with an estimated annual saving of more than twenty million tons of coal At a time when it has never been more important to economize in coal, when everyone is acutely conscious of the evils of air pollution, and when the refinement of industrial processes needs corresponding refinement in methods of heating, it is of prime importance to know whether much more coal could not be gasified so that the use of gas could be extended to general heating purposes On the grounds of cost alone, this would require the coal to be converted at high thermal efficiency in a relatively cheap plant, and clearly there must be little restriction as regards the type of coal There must also be flexibility in operation, since the more extensive is the use of gas, the more desirable will it be to suit production to variations in demand

In the light of recent technical advances it seems that all these requirements will soon be attainable, but only by having some alternative to carbonization, the principal process now used for gas manufacture The carbonization of coal, operated since gas was first introduced for lighting, is now highly developed, but it has limitations which would probably militate seriously against a further major increase in gas production To some extent these are due to the cost and inflexibility of the plant, but, more particularly, they are concerned with coal supplies which, for carbonization, must be of a special kind, rich in volatile matter to give sufficient gas, reasonably low in ash, and fusible enough to produce a good coke But, while all coal is scarce, it is this caking type which is becoming the most difficult to obtain The plans of the Coal Board are to mine a greater proportion of weakly caking coal, and more mechanization is expected to increase the production of high-ash smalls. These are likely to be the coals most readily available for gas manufacture and, except in limited quantities, they are unsuitable for carbonization It is for these reasons that a large increase in the production of gas from coal seems to require some other process We now believe that one with the desired features will soon be obtainable, and it will gasify the coal completely as a result of the initial thermal decomposition being followed by the reaction of residual carbon with steam,

$$C + H_2O \rightarrow CO + H_2$$

It is as well, however, to appreciate what such a process involves since, clearly, its chemistry is quite different from that of carbonization A gasification system absorbs the elements of water and does not reject carbon as coke; but yet, for a time at least, the gas finally obtained must be interchangeable with that from existing plants. The gas need not have the same empirical composition as coal gas, but for satisfactory behaviour in appliances, it must be of similar calorific value and density It must have calorific value of 450–500 B Th U per cu. ft and density of about 0 5 (air = 1).

The composition of coal is then sufficient to show that, in meeting this requirement, besides providing for the straightforward reaction with steam, a suitable gasification process must (a) increase th production of methane above that normally obtaine by thermal decomposition so as to give the require calorific value in the greater volume of gas obtaine per ton of coal, and (b) avoid too high a density in the gas by rejecting both carbon and oxygen This can be done by converting carbon monoxide t hydrogen by means of additional steam and then removing carbon dioxide,

$$CO + H_2O \rightarrow H_2 + CO_2$$

Until a few years before the Second World War these operations always appeared formidable Indeed it can be argued that it has been because of their that carbonization has persisted as the basic method of gas manufacture In 1935, however, the Lurg process was introduced in Germany and showed that a considerable simplification could be obtained by conducting the whole of the gasification under a pressure of several atmospheres The Lurgi process uses a generator, similar in design to a norma mechanical producer, except that it allows gasification to be carried out in steam at 20–30 atmospheres Oxygen is added to the steam to liberate the heat required by the gasification reaction, and the output is readily variable through the rate at which this oxygen and steam mixture is supplied. The unique feature is, however, the use of pressure, which is found to have several advantages it reduces gas velocities through the fuel bed so that small fuel can be gasified at high output with little loss of dust from the generator, under pressure, methane is stable at the temperature of the fuel bed and is formed during the gasification itself, steam, used in excess to prevent clinker formation, reacts in the fuel-bed with carbon monoxide, and the density of the final gas is quite normal; pressure then facilitates the removal of the carbon dioxide by washing the gas with water or, preferably, with organic solvents, which also eliminate gum formers and sulphur compounds, to give a higher standard of purity than has hitherto been attained in town gas

This process was initially developed for the gasification of lignite. Large installations have been operated on the Continent of Europe, and more are being erected It clearly has most of the desired features In fact, technically, only two further developments are required before its use in Great Britain, and these are, first, a modification of the generator so that it would gasify bituminous coals, which differ from lignite in that they tend to agglomerate when heated under pressure and, secondly, an increase in the calorific value of the gas which, at 400–450 B Th.U per cu ft, is still rather low.

Modifications to the design of the generator have been made in Germany, and tests have shown that it is now capable of dealing with a wide range of British weakly-caking coals The increase in calorific value has also been achieved, work in Britain having concentrated on this aspect It has been found that the formation of additional methane under pressure is the result of hydrogen from steam reacting with the coal and that the extent of this hydrogenation eaction can be increased if the best use is made of he pressure available

The process can therefore be regarded as satisfactory in so far as it will produce a suitable gas from ow-grade coals, and the capital charges are only about half those of carbonization. Are its overall economics also satisfactory? So far as can be ascertained without full-scale trial in Britain, the cost of gas production would, in many localities, be ower than by carbonization but not low enough for he expansion of gas production as contemplated by Dr Dent In its present form, therefore, the Lurgi process is mainly to be regarded as a method for widening the range of the coals used for gas-making, and it is important on that account Is there, however, opportunity for the further development of what is still a relatively new process? Dr Dent hinks that there is

Because of the nature of the process, development will not be confined to any single feature As already indicated, the conversion of coal to gas involves a number of steps, and minimum costs will only be achieved if each is carried out at maximum efficiency If gas is to be competitive for general heating, production processes must leave no margin of avoidable losses and take full advantage of there being no estriction by natural laws such as those which limit the efficiency of utilizing coal for power generation Then it is realized that, while a first attraction of the Lurgi process is that the gasification in steam, the conversion of carbon monoxide, and the formation of methane occur in the one fuel bed, the individual performances do not compare favourably with those attained under other conditions, and they are all capable of improvement

Consideration indicates that maximum performances will only be obtained by having separate control at each stage, and this is quite logical Efficient reaction with steam requires a high temperature, efficient conversion of carbon monoxide a low one, while the production of methane is favoured by an intermediate range with the partial pressure of hydrogen as high as possible Optimum conditions for each cannot be obtained in the same fuel-bed, and all experimental work indicates that individual control will improve both efficiency and flexibility In more detail, developments being considered are ncreasing steam decomposition by operating with higher temperatures in the fuel bed, and withdrawing the ash as a slag—the thermal efficiency of gasification will then approach 80 per cent, obtaining the maximum efficiency in carbon monoxide conversion by using catalysts in a separate stage incorporating the removal of carbon dioxide, and enriching the gas by means of the hydrogenation reaction, and again in a separate stage and after steam, carbon monoxide and carbon dioxide have been removed o that the pressure of the remaining hydrogen is as high as possible

The plant lay-out will then consist of boiler plant, oxygen plant, gasification stage, condensation with rejection of tar and liquor, removal of hydrogen sulphide, conversion of carbon monoxide and removal of carbon dioxide, enrichment stage, and final purification

This system underlies a programme of research being carried out in Britain by the Gas Council It will be appreciated that it is more comprehensive than the present Lurgi process and represents rather the full development of pressure gasification for the production of town gas Thus, while the gasification stage may have standard or slagging generators, it may also include units for the fluidized or suspended gasification of powdered coal, breeze, tar and petroleum oils, as well as for the reforming of natural and other fuel gases, and similarly in the enrichment stage In fact, once a works has been laid out for pressure gasification with oxygen, steam supplies, etc, it would be relatively simple to effect modifications in the gasification and enrichment stages to suit any raw material. Further, whatever raw material were used, the composition of the final gas could correspond with any calorific value up to 1,000 B.Th.U per cu. ft, a fundamental feature characteristic of pressure operation, as reactions can be governed by equilibria at every stage, this is different, for example, from a process of thermal decomposition such as carbonization, in which so much depends upon the nature of the coal As in Lurgi gas, there would be only four simple gas constituents—namely, carbon monoxide, hydrogen, methane and nitrogen—but now, with the proportions of each constituent under full control, the methane determines the calorific value, the ratio of hydrogen to carbon monoxide determines the output, and the nitrogen controls the gas density Eventually, there might be no restriction to the present properties of coal gas, and then gas composition could be chosen to suit distribution and use

When it is coal that is being hydrogenated in the enriching stage of the system outlined above, the solid residue might be transferred to the gasification stage for the production of hydrogen-rich gas It should be noticed, however, that during hydrogenation, most of the sulphur in the coal is removed and recovered as hydrogen sulphide, and the residue contains only 0 1–0 2 per cent of this constituent Being also readily combustible, the residue might therefore find other applications, for example, as basis of a solid smokeless domestic fuel or as a fuel for power stations, when the flue gases would no longer call for treatment

The significance of pressure gasification is due to its adaptability in so many directions which embrace most, if not all, of the production features that have been sought at various times With this unique characteristic, it goes far beyond the immediate requirement for an alternative to carbonization, and offers a unified system of gas-making capable of suiting any foreseeable circumstances If the gas industry is to become the purveyor of refined heat for general purposes—a greater part than it has played in the past—then it needs some such system to facilitate the assumption of its wider function, opportunity for which has been increased by the broader groupings set up in Britain by nationalization. Particular mention might be made of the high rates of gasification obtained under pressure, which allow high outputs from individual gas-making units without an increase of the labour force, while, more obviously, the distribution of gas over longer distances at the high pressures would allow manufacture to be concentrated in large works, sited with respect to supplies and raw materials, whatever they might be Finally, the overall cost of gas production on the basis of heat units should be little more than twice the cost of pithead coal Taking into account its greater efficiency in use, its high purity and its convenience this should make gas competitive with solid fuel for a wide range of heating purposes, and it is therefore believed that gas will satisfy a far greater proportion of the demand for smokeless fuel than is generally contemplated Then, with production of an overall thermal efficiency of approximately 80 per cent, there will be a considerable saving in coal

The technical developments which have been envisaged are not regarded as aims for the distant future Vigorous investigations of gasification processes are being carried out in various parts of the world, and much is now known of the use of oxygen, slagging operation, powder techniques, hydrogenation, oil gasification and so on What remains to be done consists mainly of selecting those elements which lead to the highest performance and integrating them into the pressure system Without minimizing the effort required for this final stage, it is nevertheless believed that, with the Lurgi process as a basis on which to build, a flexible system of gas production could be made available in a few years

MEDICAL RESEARCH COUNCIL

REPORT FOR THE YEAR 1952–53

A FEATURE of the report for 1952–53 of the Medical Research Council* is an article entitled "Medical Research in the Tropics", which discusses the origin and work of the Colonial Medical Research Committee set up eight years ago by the Secretary of State for the Colonies and the Medical Research Council, under the chairmanship of the Secretary of the Medical Research Council During the eight years since the establishment of this Committee, new centres of research have been built at Fajara in the Gambia, Mwanza in Tanganyika, Oshodi in Nigeria, Kumba in the Cameroons, and Kerugoya in Kenya, and the Rockefeller Foundation generously transferred to the Colonial Office its virus research institutes at Entebbe in Uganda and Yaba in Nigeria Research laboratories were built at Makerere College in Uganda, and support was given to research in Malaya and to work on malaria in Tanganyika The Committee also advised that a Colonial Medical Service should be created, and, although this was instituted in 1949, recruits to it have been slow in coming forward

Recently, however, the control of this Colonial research has been reorganized It is not easy to disentangle from the paragraph describing this reorganization exactly what has been done, but the new arrangements provide "for decentralising to inter-territorial bodies the immediate scientific supervision of research schemes based in the colonies" and a "home-based organisation will continue to centre on the Colonial Medical Research Committee, whose terms of reference have been revised to accord with the newer concept of its duties" One is tempted to wonder, as one reads and tries to understand exactly how this complex organization works, which seems to the authorities to be the more important—the administrative machine or the men and women, at home and abroad, on whose devoted and unpublicized labours the whole organization, and also the health of a great many people, depend

The rest of the Council's report follows the plan adopted during the past few years It does not attempt to record the results of the work of the Council's separate research establishments, but gives only brief summaries, in the form of headings, of the work of each department For further information the reader is referred to the bibliography of papers published by individual research workers. The practice now is to discuss, under the title "Some Aspects of Medical Research", selected general trend of medical research "often from a broader standpoint than that of the contributions made by work within the Council's own programme", a practice which "inevitably omits mention of many investigations in which the Council's workers take part"

Following this practice, the present report discusses in the section on "Some Aspects of Medical Research" high-altitude research and the Everest expedition, cell metabolism, peripheral nerve injuries, the diagnosis and treatment of virus diseases, the grafting of tissues, the biosynthesis and metabolism of some simple nitrogenous compounds, high blood pressure, the use of cortisone and adrenocorticotropic hormone in rheumatic diseases, studies of twins, hazards in the use of pesticides, the use of hypothermia in surgery, and lipid metabolism The section is a valuable one, but some readers, however much they welcome contributions of this kind, will regret that it is no longer possible to have reports of the work being done by individual workers G LAPAGE

FORESTRY IN THE GOLD COAST

REPORT FOR THE YEAR 1952–53

THE report for the year 1952–53 of the Forest Department of the Gold Coast* gives evidence that under the new governmental régime in the Gold Coast the forests and their well-being are not to be neglected Twenty years ago the gazetted forest staff numbered twelve officers, mostly stationed in the south, the northern territories scarcely coming into forestry consideration by the forestry authorities At present, so the Chief Conservator of Forests states, the sanctioned Colonial Forest Service is thirty-five officers In addition, the sanctioned subordinate staff consists of twenty-four senior forest rangers and a hundred and twenty forest rangers with the necessary complement of forest guards Such a trained staff will, it may be hoped, be continued under the new government

The report shows most satisfactory progress The formation of a working plans branch, concerned with the enunciation of the approved forest policy, points to this In the report for 1948–49 (see *Nature*, 167, 598, 1951) it was stated that a new and detailed forest policy formulated in 1946 had been formally approved by the Governor in Council and that one of the chief aims was the management of permanent forest resources by methods that would achieve maximum productivity on the basis of a sustained yield This is a familiar aspiration, often repeated in the past in forestry reports, but the Department is making considerable progress towards its fulfilment The policy is briefly summed up under one heading—reservation—most of which has reached completion except in the Northern Territories Management over 4,583 square miles of forest reserves has now been covered by enumeration surveys, mainly on a one per cent basis of sampling, and a working plans branch was set up during the year, the total area of reserves under working plans being 880 square miles

---

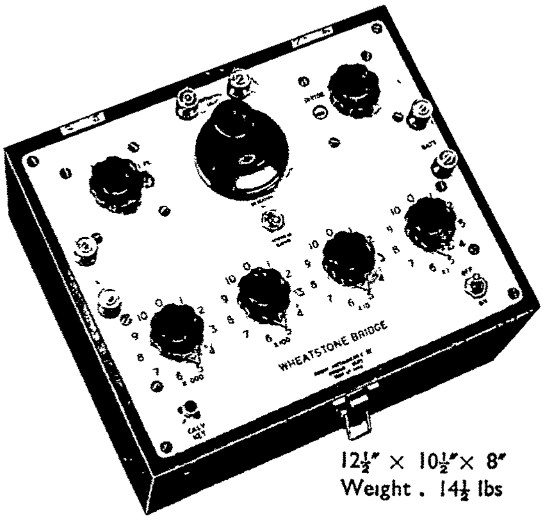
* Committee of Privy Council for Medical Research Report of the Medical Research Council for the Year 1952–1953 (Cmd 9184) Pp v+269 (London H M S O, 1954) 7s 6d net

* Gold Coast Government Report on the Forestry Department for the Year 1952 53 Pp ii+24 (Accra Government Printing Department, London Crown Agents for the Colonies, 1954) 2s 6d net

DORAN

Self-contained Wheatstone Bridge

Cat. No. E.3378



12½″ × 10½″× 8″
Weight . 14½ lbs

The instrument illustrated comprises four decade resistance units totalling 11,110 ohms with ratio arms to cover a range of measurement of from 0·01 ohm to 10 megohms. The galvanometer provided has ample sensitivity for the greater part of the range, but terminals with change-over switch enable an external galvanometer to be employed for more precise work.

Further details of this and a precision type bridge will be found in List 108 N.

Tel STROUD 462

DORAN INSTRUMENT CO. LTD.
Stroud, Glos.

London Office
Tel ADD 2369

THE WORLD'S GREATEST BOOKSHOP

FOYLES
• FOR BOOKS •

FAMED CENTRE FOR SCIENTIFIC BOOKS

All new Books available on day of publication Secondhand and rare Books on every subject. Stock of over three million volumes

Subscriptions taken for British, American and Continental magazines, and we have a first-class Postal Library

Foyles have depts for Gramophone Records, Music, Stationery, Handicraft Tools and Materials.

We BUY Books, Coins, Stamps

119-125 CHARING CROSS ROAD
LONDON WC2

Gerrard 5660 (16 *lines*) ★ *Open* 9–6 (*inc Sats*)

Two minutes from Tottenham Court Road Station

THE PHYSICAL SOCIETY'S 39th EXHIBITION
of
SCIENTIFIC INSTRUMENTS AND APPARATUS

will be held at the
ROYAL HORTICULTURAL SOCIETY'S
NEW HALL
Greycoat and Elverton Streets, Westminster,
S W 1
from 25th–28th April, 1955

The *Handbook*, which will be published in connection with the Exhibition, is not only a catalogue, but is a most valuable reference book of new developments in British scientific instruments and apparatus

During the Exhibition, discourses on scientific subjects of general interest will be given

The Annual Craftsmanship and Draughtsmanship Competition takes place early in the year, and the winning entries will be exhibited

1, Lowther Gardens, Prince Consort Road,
London, S W 7

Important Teaching Aid

PHYSICOCHEMICAL CALCULATIONS

By **E. A. GUGGENHEIM,** *Professor of Chemistry,* and **J. E. PRUE,** *Lecturer in Chemistry, University of Reading, Reading, England*

This book is the outgrowth of the long educational experience of one of the leading modern experts in thermodynamics, Professor E A Guggenheim, and of his collaborator 172 problems of physical chemistry are presented in a most original manner Each problem is divided into four sections, namely

1 Data, including detailed references to the sources
2 Introduction, where the procedure for the calculation is described
3 Calculation, including full numerical details with particular attention to units, whenever graphs have been used, small-scale reproductions of these are given
4 Discussion, in which the significance of the results and their relation to other work is assessed

This book, therefore, teaches students how to master the evaluation of their own experimental findings and how to derive numerical results from an interpretation of the original literature In selecting and grouping the problems, the authors have tried to make clear how different experimental methods can be applied for the establishment of a particular physical constant and how the results of these different methods compare with each other in reliability and accuracy For example, they present ten methods for the establishment of Avogadro's number

The book is destined to become an indispensable aid in every course in physical chemistry and chemical physics

CONTENTS

Atomic and Molecular Weights
Avogadro's Number
Molecular Velocities
Interatomic Distances
Moments of Inertia
Characteristic Frequencies
Electric Moments and Polarizabilities
Energies and Enthalpies
Entropies
Heat Capacities
Equation of State
Mixtures of Non-Electrolytes
Electrolyte Solutions
Conductances and Diffusion of Electrolytes
Gaseous Equilibria
Solution Equilibria
Acid-Base Equilibria
General Electrolyte Equilibria
Solid Surfaces
Liquid Surfaces
Gas Kinetics
Solution Kinetics
Radioactivity

Ask for our twelve-page descriptive folder

1955 XII, 491 pages 80 diagrams 53*s*

For U S A Interscience Publishers Inc , New York

NORTH-HOLLAND PUBLISHING COMPANY
AMSTERDAM

MACMILLAN BOOKS

Advanced Level Examples in Physics

R. V. JOHNS, M.A., B.Sc.

Lecturer in Physics and Mathematics, City of Liverpool College of Technology

W. F. WARE, B.Sc., A.Inst.P.

Senior Physics Master, Cathays High School for Boys, Cardiff

This book of numerical examples is designed to supplement the theoretical and laboratory work of students preparing for examinations in Physics at the Advanced level of the General Certificate of Education and for Intermediate Degree examinations. Some 1,000 examples have been arranged by topics and carefully graded in difficulty. Contents are arranged under the headings Mechanics and Properties of Matter, Heat, Light, Sound, and Magnetism and Electricity. 16*s.*

A Text-book of Electricity and Magnetism

E. R. NOAKES, M.A., F.Inst.P.

This is the new, Third Edition of a book which will meet the need of those taking Intermediate degree courses and the Advanced and Scholarship Examinations of the General Certificate of Education. All the usual topics required at this stage are dealt with, and where necessary calculus is used. Among the special topics discussed are the conduction of electricity through gases, atomic physics and modern views on ferro- and terrestrial magnetism. *Third Edition.* 14*s.*

Comprehensive Inorganic Chemistry

Edited by M. CANNON SNEED, J. LEWIS MAYNARD and ROBERT C. BRASTED

Volume III—The Halogens, by ROBERT C. BRASTED

Comprehensive Inorganic Chemistry is an eleven-volume reference work on the chemical elements and their inorganic compounds. In this Third Volume the significant advances of recent years are fully reflected in a broad treatment of halogen chemistry. Both basic principles and their applications are exhaustively covered, as well as the new processes, methods of production, and the chemistry of compounds which have lately become so important. 35*s.*

The Light Metals Handbook

Text and Tables

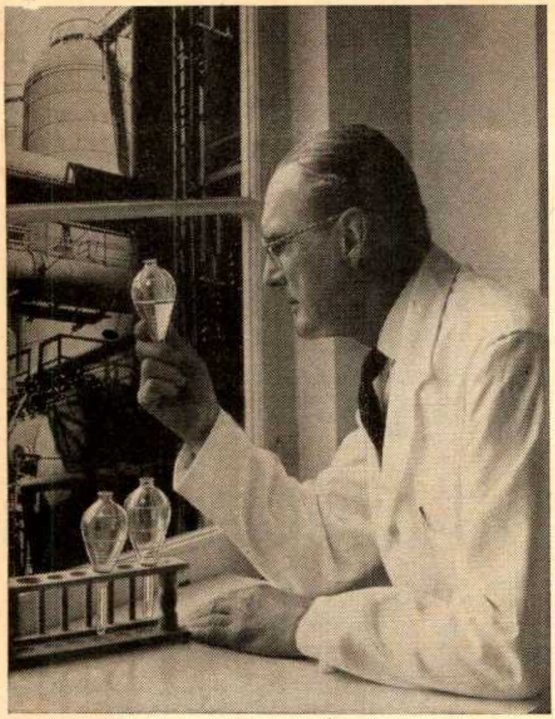
GEORGE A. PAGONIS

Light Metals Resarch Laboratory, San José, California

This book simplifies the task of gathering facts and information on aluminium- and magnesium-base alloys. It was written to serve all aircraft, industrial, and civil engineers, fabricators and light metal foundries, as well as men developing engineering specifications. It is published in two volumes, text and tables, bound together in detachable sections. 63*s.*

All prices are net

St. Martin's Street, London, W.C.2



"If it were not for these little things..."

"... we wouldn't get far with that plant. It's the research work that produces the new motor fuels and new additives, and gives the motorist his extra speed and smoother running."

".... and it's the scientific glassware in the laboratory that counts for most in all initial pilot work. This glassware **must** be reliable, **must** be precise, **must** be strong. A broken measure in the middle of an experiment may ruin everything!"

"That's why we always use 'PYREX' Brand Glass in our Laboratories. It is heat and acid proof, and with its low coefficient of expansion it can be made so robust that breakages are few and far between."

'PYREX' brand laboratory glassware
is made only by James A. Jobling & Co. Ltd., Sunderland
Large new catalogue FREE
Send name, address and position in firm

MADE IN ENGLAND PYREX
REGD TRADE MARK

JAMES A JOBLING & CO LTD
Wear Glass Works Sunderland

THE ONLY MAKERS OF 'PYREX' BRAND GLASS IN THE UNITED KINGDOM

Announcing the reprint of
Two Rare Works...

THE GENERA of FUNGI
by F. E. CLEMENTS and C. L. SHEAR
8vo. 496 pp. 58 plates. £5 7s. 6d.

◆

FLORA OF THE ROCKY MOUNTAINS & ADJACENT PLAINS
by P. A. RYDBERG
8vo. 1144 pp. £5 7s. 6d.

◆

HAFNER PUBLISHING CO., LTD.
Star Yard, Carey St., W.C.2

WANTED TO PURCHASE
Scientific books & periodicals

Entire libraries, and smaller collections; sets and runs, foreign and domestic.

WALTER J. JOHNSON, INC.
125 East 23 Street, New York, 10, N.Y., U.S.A.
Cable Address: BOOKJOHNS, NEW YORK
British Office: ACADEMIC BOOKS, LTD.
129 Queensway, London, W.2

PRESS for making KBr and KCL DISCS
as used in I-R and U-V solid state study.

INFRA-RED CELLS
Variable path-length cells for liquids.
Fixed path-length cells for liquids and gases.
Descriptive Catalogue CH388/N11 free on application

HILGER & WATTS LTD.
98 St. Pancras Way, London, N.W.1

INORGANIC QUALITATIVE ANALYSIS:

SEMI-MICRO METHODS

BY

H HOLNESS

M Sc, F R I C, Senior Lecturer in Chemistry, South-West Essex Technical College

This is an essentially practical book to be used "on the bench" The whole work has been thoroughly tested in practice and every experiment described has been tried out with classes of students All students, up to and including those sitting for the B Sc general examination in chemistry for London University, will find this a valuable book Illustrated 12*s* 6*d*

PITMAN

Parker Street . Kingsway London, W C.2

The SCIENTIFIC BOOK SUPPLY SERVICE

(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

TRADE JAYGO MARK

Special & Standard Scientific Apparatus & Glassware

GLASS EQUIPMENT FOR FUME ABSORPTION

LABORATORY HOSPITALS AND PILOT PLANT EQUIPMENT FOR ANALYTICAL EDUCATIONAL AND RESEARCH PURPOSES

THE JAGO COMPANY

90 RUSHOLME ROAD, MANCHESTER, 13

Just Published — Volume II

Fluorine Chemistry

Complete in 3 volumes

Edited by J H Simons

December 1954, 565 pp, illus, 108s

Contents

Fluorine-Containing Complex Salts and Acids
By Alan G Sharpe

Halogen Fluorides—Recent Advances
By H J Emeléus

Analytical Chemistry of Fluorine and Fluorine-Containing Compounds
By Philip J Elving, Charles A Horton, and Hobart H Willard

Organic Compounds Containing Fluorine
By Paul Tarrant

Metallic Compounds Containing Fluorocarbon Radicals and Organometallic Compounds Containing Fluorine
By H J Emeléus

Fluorocarbon Chemistry
By J H Simons and T J Brice

The Infrared Spectra of Fluorocarbons and Related Compounds
By D G Weiblen

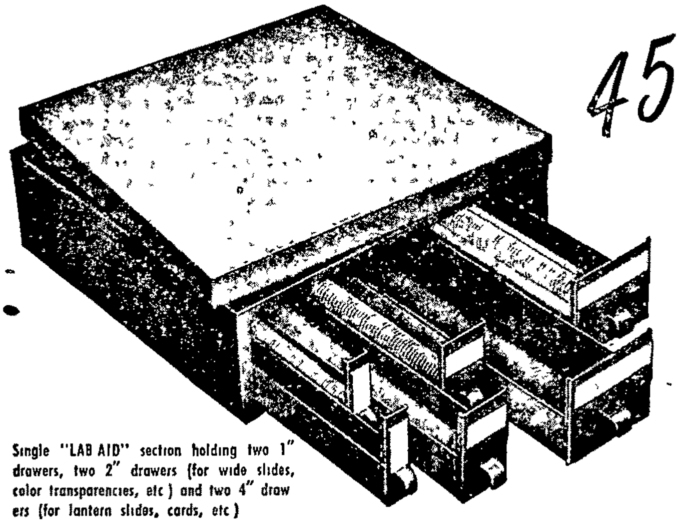
Author Index—Subject Index

New PHYSICAL CHEMISTRY catalogue available upon request

Academic Press Inc.

125 East 23 Street, New York 10, N Y, U S A

British Office: ACADEMIC BOOKS LTD,
129 Queensway, London, W 2



45% greater capacity

cuts filing costs . . .

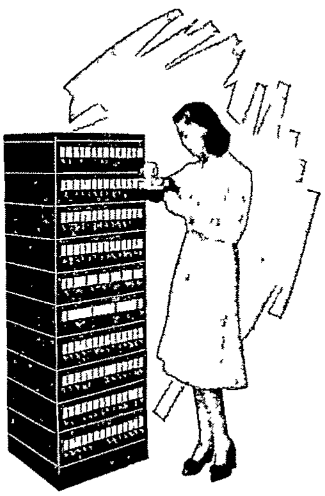
saves floor space

Single "LAB AID" section holding two 1" drawers, two 2" drawers (for wide slides, color transparencies, etc) and two 4" drawers (for lantern slides, cards, etc)

How can a Technicon "LAB-AID" filing cabinet measuring only 19" square by 5" high hold up to 6500 (average) one-inch microslides? The single section illustrated here with its drawers extended will show you why . it's because there are no thick bulkheads between drawers — no space-consuming buttresses, no bulky tracking guides Yet, close-set as they are, every drawer slides straight and true . easily, smoothly, without binding

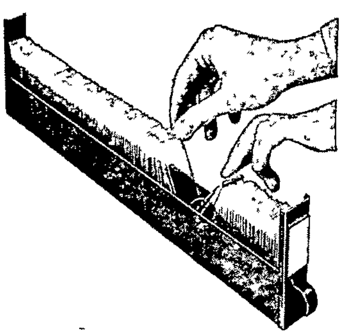
Drawers are freely interchangeable, too, thanks to the unique "LAB-AID" unit-gauge track system, so that you can intermix 1" drawers with 2" drawers (even 4" drawers, if you like) according to your needs

Staunch, fireproof "LAB-AID" units are strongly built of heavy gauge steel for a lifetime of satisfactory use Beautifully finished in olive green enamel, with combination drawer-pulls and label holders Separate bases and finishing cap panels make complete units of any number of sections your filing needs require, expandable at will at any future time.



A stack of ten sections, complete with base and cap panel Interlocking design lets you pile sections right up to the ceiling Staunch 'LAB AID' construction easily bears the heavy weight of solidly packed slides

For filing current slides, the removable spring separator lets you riffle through them as easily as you flip the pages of a book easy to file, easy to find Slip it in when you need it, take it out when you use the drawer for storage filing



TECHNICON Lab-aid laboratory filing cabinets

Technicon "LAB-AID" filing cabinets have long been standard filing equipment in laboratories throughout the world Now made in France, they can be easily imported into the United Kingdom.

COMPAGNIE TECHNICON
Postal Address only in U K ·
7 Lytton Gardens, Wallington, Surrey

Towers

SCIENTIFIC EQUIPMENT

AUTOMATIC FRACTION COLLECTOR

for chromatographic analysis

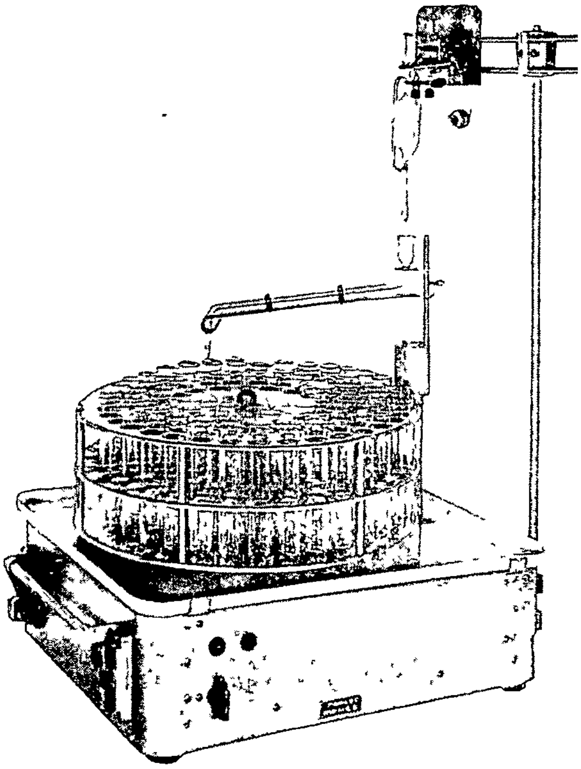
Designed *at the National Institute for Medical Research, Mill Hill, London, N W.7*

★ Reliable motor-driven operation

★ Interchangeable racks for 100 collecting tubes

★ Volume of fractions 1 to 50 ml by siphon balance

★ Mechanism protected by vitreous enamelled tray



Full details sent with pleasure on request

◇

Manchester 44, Chapel Street, Salford 3 (Blackfriars 2677)
Liverpool 134, Brownlow Hill, Liverpool 3 (Royal 4074)
Stockton-on-Tees 28, Bridge Road (Stockton 65141)
London Industrial Estate, Uxbridge, Middx (Uxbridge 8461)

J. W. TOWERS & CO., LTD.
HEAD OFFICE & WORKS, WIDNES
TELEPHONE 2201-5

Towers

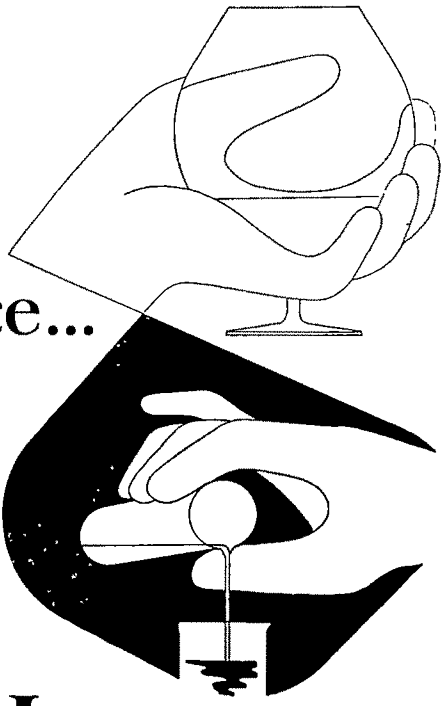
THORIUM LIMITED

Makers of
LANTHANUM OXIDE
99·9% Pure

THORIUM LIMITED 10 STOREY'S GATE WESTMINSTER S W 1

RARE EARTH CHEMICALS

'Professor Leeds then showed the Society an easy method for
The Detection of Minute Traces of Water in Alcohol
Anthraquinone is not only converted into hydroanthraquinone by zinc dust and caustic soda, but also by treatment with sodium amalgam When the hydroanthraquinone so formed is brought into contact with water, there is formed a clear, dark red solution of sodium hydroanthraquinone'

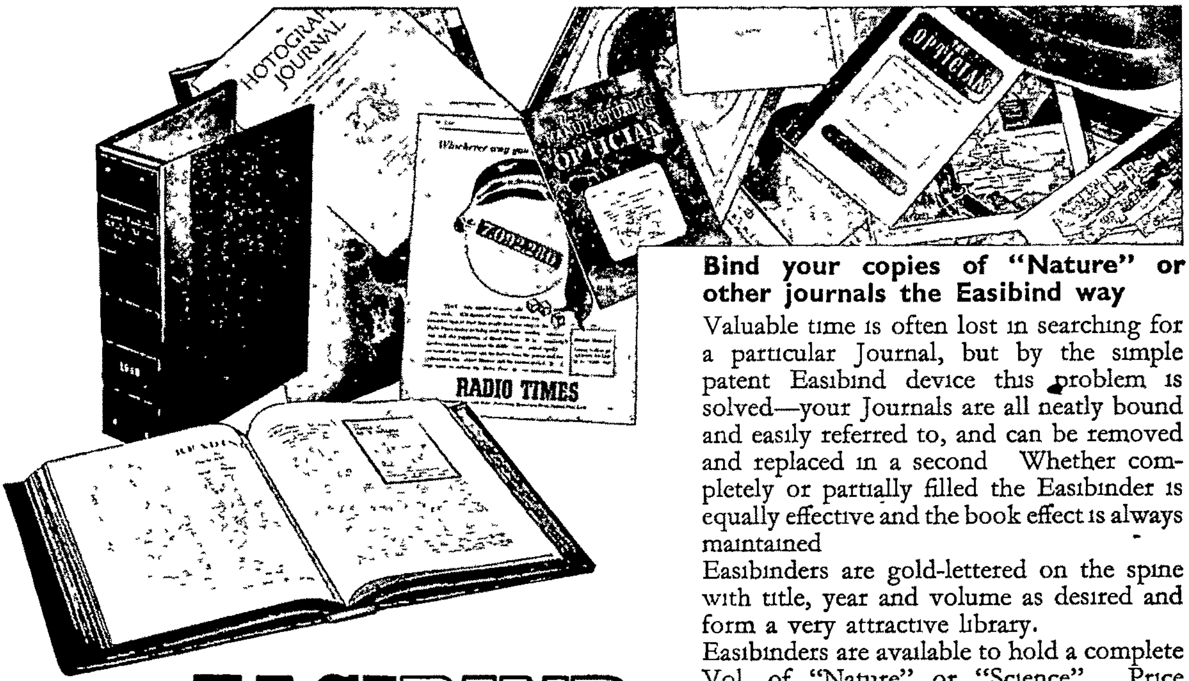


Just a minute trace...

Industrially as well as scientifically, the determination of traces of water has acquired much greater significance than it had in 1879, when this paragraph appeared in the first volume of the Journal of the American Chemical Society The preferred method of moisture determination to-day is that developed by Karl Fischer B D H has devised simplified methods for its application and supplies prepared reagents ready for use
A booklet on the method may be obtained on request

LABORATORY B·D·H CHEMICALS

THE BRITISH DRUG HOUSES LTD B D H LABORATORY CHEMICALS GROUP POOLE DORSET
LC/P/7



Bind your copies of "Nature" or other journals the Easibind way

Valuable time is often lost in searching for a particular Journal, but by the simple patent Easibind device this problem is solved—your Journals are all neatly bound and easily referred to, and can be removed and replaced in a second Whether completely or partially filled the Easibinder is equally effective and the book effect is always maintained

Easibinders are gold-lettered on the spine with title, year and volume as desired and form a very attractive library.

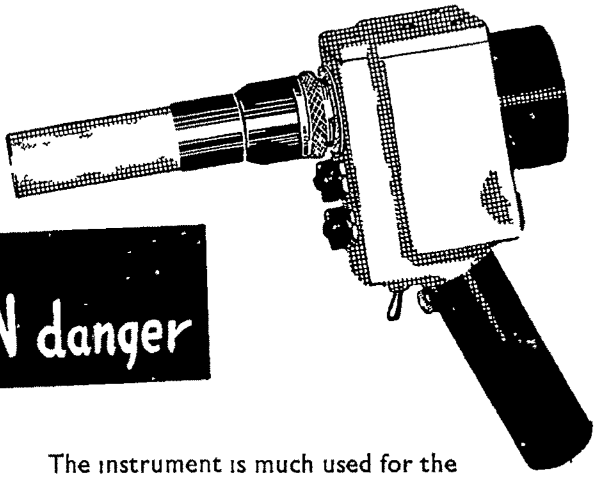
Easibinders are available to hold a complete Vol of "Nature" or "Science". Price 13s, including title and year Postage rates: for one binder, 1s 3d.; up to four binders, 2s ; up to eight binders, 3s.

EASIBIND LTD

84 NEWMAN STREET, LONDON, W.1 • Phone: MUSeum 2141

STATIC

an UNSEEN danger



The Statigun measures potential gradient in air over the range 0-300kv/ft Attachments enable insulation resistance up to 10^{13} ohms and surface charge density up to 3×10^{-9} coulombs/cm^2 to be measured

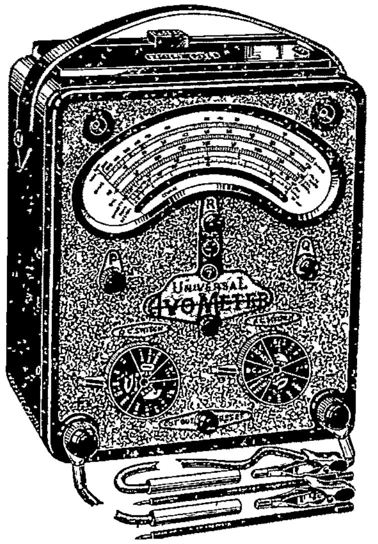
The instrument is much used for the investigation of static charges in the textile, plastics, paper, rubber and explosives industries as well as in hospital operating theatres. Further details are given in leaflet No F 123 available on request.

BALDWIN *scientific instruments*

BALDWIN INSTRUMENT COMPANY LTD DARTFORD KENT • TEL 2948

Instrumentally Speaking

Wherever electricity is used in industry, there is a need for electrical measuring instruments. Phenomenal development in the war and post-war years has produced a need for such a multiplicity of instruments of different kinds that there is a prevailing tendency towards the slowing down of maintenance and laboratory work through having too many instruments in use. Incidentally, too much test gear also means too much expense. The answer to such problems is provided by "Avo" MULTI-RANGE instruments.



The Model 7 Universal AvoMeter is a typical example of a modern "AVO" multi-range meter It is a combination A C /D C instrument providing on a 5-inch hand calibrated scale 50 ranges of readings of Current, Voltage, Resistance, Capacitance, Power Output and Decibels The total resistance of the instrument is 500,000 ohms, and its small power consumption and precision accuracy make it the choice of radio, television and electrical engineers throughout the world An external accessory is also available for measuring Power and Power Factor

Write for a FREE copy of the latest Comprehensive Guide to "AVO" Instruments

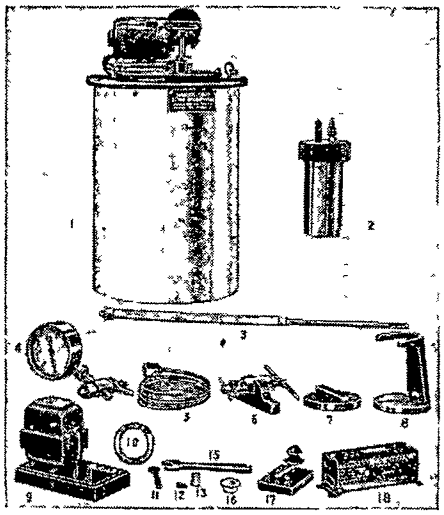
'AVO' Precision ELECTRICAL TESTING INSTRUMENTS

MODEL 7 UNIVERSAL AVOMETER
MODEL 8 UNIVERSAL AVOMETER
MODEL 40 UNIVERSAL AVOMETER
HEAVY DUTY AVOMETER
"AVO" ELECTRONIC TESTMETER
"AVO" ELECTRONIC TEST UNIT
"AVO" SIGNAL GENERATOR
"AVO" UNIVERSAL BRIDGE
"AVO" VALVE CHARACTERISTIC METER
D.C. & UNIVERSAL AVOMINORS
"AVO" LIGHT METER
etc., etc.

Sole Proprietors and Manufacturers.

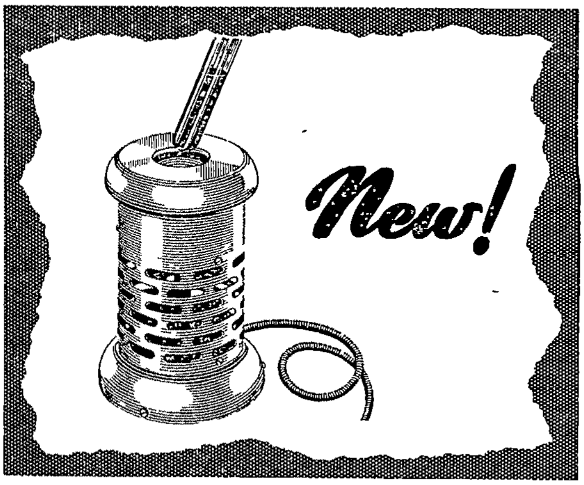
The Automatic Coil Winder & Electrical Equipment Co. Ltd.
Winder House, Douglas Street, London, S.W.1. VICtoria 3404-9

THE **NEW** "MAHLER-COOK"
EASY-SEAL
BOMB CALORIMETER
(Conforming to latest specifications)



An improved apparatus, of our own design and manufacture, for the Calorific determination of Coals, Oils, Fuels, Foodstuffs, etc etc and for Sulphur and Chlorine determinations
Reduction in price Please send for information and prices

CHAS. W. COOK & SONS LTD.
97 Walsall Road, Perry Barr,
Birmingham, 22B, England



ELECTROTHERMAL "BUNSEN"
(Pat pdg Regd Design 875,606)

An indispensable apparatus for use in laboratories for heating test-tubes, crucibles, etc Available from all Laboratory Supply houses. Write for leaflet now

Safe, efficient and economical in use. Guaranteed for 12 months.

Electrothermal Engineering Ltd.
270 NEVILLE ROAD, LONDON, E.7 Telephone GRAngewood 0055

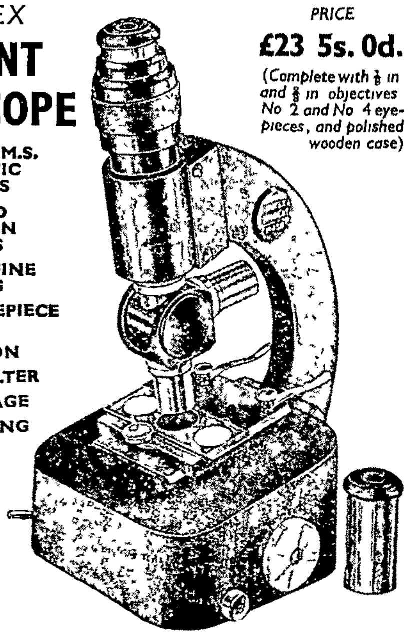
THE BRITEX

STUDENT MICROSCOPE

PRICE

£23 5s. 0d.

(Complete with ⅔ in and ⅙ in objectives No 2 and No 4 eyepieces, and polished wooden case)



STANDARD R M.S. ACHROMATIC OBJECTIVES

STANDARD HUYGENIAN EYEPIECES

COARSE AND FINE FOCUSING

DOUBLE NOSEPIECE

BUILT-IN ILLUMINATION

DAYLIGHT FILTER

PATENTED STAGE

STAGE LEVELLING DEVICE

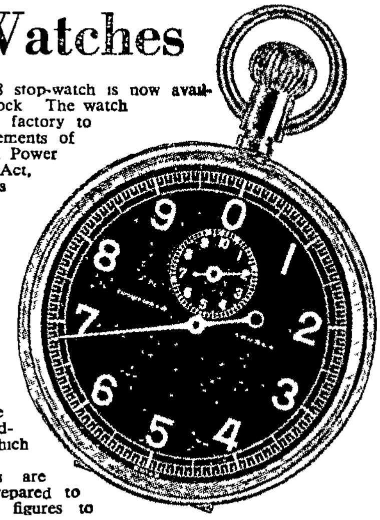
Its design is the result of many years of research and experience on the production of a high quality, soundly constructed and reasonably priced microscope

Available from all reputable instrument dealers
Literature on request

BRITEX (SCIENTIFIC INSTRUMENTS) LTD.

Manufacturers of Microscopes, Magnifiers, Telescopes, etc
523 4, Bank Chambers, 329, High Holborn, London, W C 1

Stop Watches



OUR improved model 308 stop-watch is now available for delivery from stock The watch is specially timed at the factory to conform with the requirements of the Ministry of Fuel and Power (Elec Supply Meters Act, 1936) and the requirements of the N P L for a high grade stop watch with a 1/30th second escapement suitable for laboratory use

The dial is calibrated 0-10 mins the large band making 1 revolution in 10 secs The size of the watch, 22 ligne, with a dial diameter of 1¾ in, allows the use of a very open scale thus facilitating the reading of the sub-divisions which are graduated 1/20 sec

Black or white dials are available and we are prepared to luminise the hands and figures to special order

A comprehensive range of stop-watches is available for all purposes
A copy of our new illustrated catalogue will be gladly sent on request

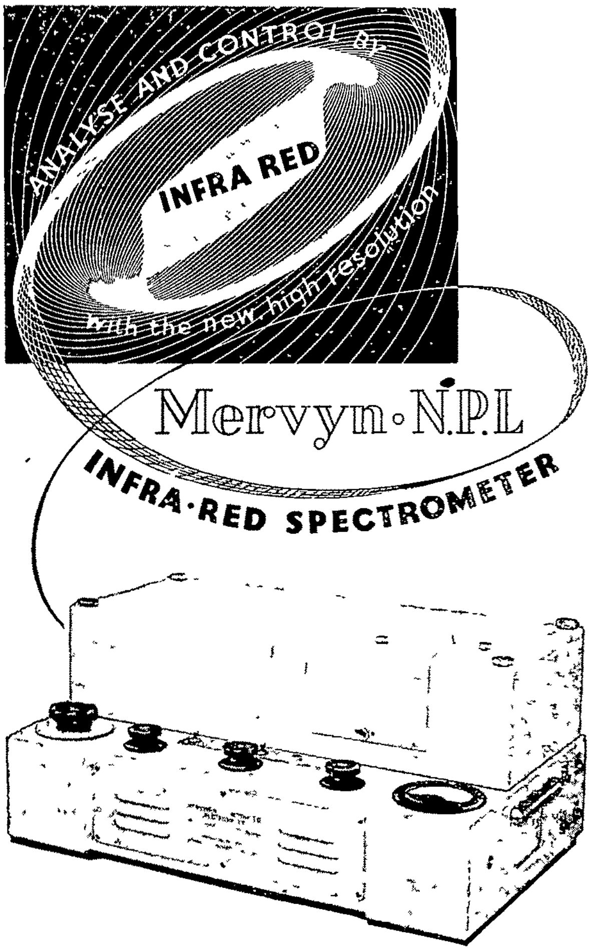
Guaranteed repairs Timing service Certification

CAMERER CUSS

Timing Division

Makers of Good Clocks & Watches since 1788
AT
NEW OXFORD STREET, LONDON, W.C.1
MUSeum 8968/9

Our only other address, 91 Kingsway, W C 2



NOW—Infra-red analysis enters a new phase with the development of this Mervyn engineered instrument using Merton—N.P.L. diffraction gratings.

Here is the long awaited high resolution instrument for the 1 μ — 4 μ region. Of great stability, it reads percentage transmissions direct.

USING A COMPLETELY NEW ELECTRONIC COMPENSATING SYSTEM

This versatile instrument is compact and simple to operate Has many applications in the manufacture of petroleum products, plastics, detergents, pharmaceuticals and other processes where the high cost of contemporary equipment has restricted the use of Infra-Red techniques

Send for full information to Dept IS 4

MERVYN INSTRUMENTS

ST. JOHN'S, WOKING, SURREY.
Telephone WOKING 2091

PB 01

CAMBRIDGE
DIRECT READING
pH
INDICATOR

An instrument characterized by portability, robustness and great stability, covering the full range of 0 to 14 pH Directly readable to 0 1 pH, and by estimation easily to 0 05. The new design (illustrated) incorporates a second scale in millivolts (—400 to +1000), reading to 5mV

All mains operated

Details are given in **SHEET 294-N**

CAMBRIDGE
INSTRUMENT CO. LTD.
13 GROSVENOR PLACE, LONDON, S.W.1
WORKS LONDON & CAMBRIDGE

We Export for Dollars

WM. DAWSON & SONS, LTD.

World's Largest Stockists of
Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?
Suppliers to All Leading Universities, Public Libraries and Institutions of the World. Catalogues issued

SELLING?
Specialists in Scientific, Technical Books and Publications of all Learned Societies

Why not consult us first?

· 102 WIGMORE STREET, LONDON, W.1
Telephones: Wel 7948; *Amb* 5991

Under research, sylvicultural research work in the high forest zone has reached a successful stage which will enable results to be placed at the disposal of the working plans branch. Under local authority forestry the introduction of a new system of local government has necessitated a revision of the forest reserve rules and by-laws. Here the necessary amendments have been made in order to enable alterations in the by-laws to be made. The destruction of forest land by farming has increased owing to the high price offered for cocoa; it is estimated to have been 780 square miles a year, and the amount of high forest outside forest reserves now remaining is assessed at 6,327 square miles. Most damage has been done in Ashanti. No control of this farming has yet been achieved, and it is altogether a great blot on the administration in Africa generally—under other governments besides the British.

Three other facts emerge from the report. The control of timber concessions is under the chief conservator of forests. Secondly, plans have been made for the expansion of the training of the subordinate staff which it was hoped to bring into force in 1954. Finally, advice is always available on technical subjects to mining companies and others on the establishment and management of fuel and pole plantations upon which progress is being made in many parts of the country. E. P. Stebbing

J.-S. BAILLY, AN EIGHTEENTH-CENTURY FRENCH SAVANT

In a publication entitled "Jean-Sylvain Bailly, Astronomer, Mystic, Revolutionary, 1736–1793" (*Trans. Amer. Phil. Soc.*, N.S., 44, Part 1, 427–538, 1954. From the American Philosophical Society, Independence Square, Philadelphia 6, Pa., 6 dollars), Edwin Burrows Smith gives an account, including a very comprehensive bibliography and index, of one who was a statesman, astronomer and savant. A member of the French Academy and of the Academy of Inscriptions, Bailly was president of the Third Estate and of the National Assembly and was Mayor of Paris during 1789–91. This meteoric career came to an abrupt end soon after his retirement at Melun, where he was seized, charged with conspiracy and executed in 1793.

Born into an essentially artistic milieu, Bailly abandoned the arts to study Newtonian physics, became a respected astronomer and won wide recognition throughout Europe for his research on Jupiter's satellites. Later on, however, he concentrated on the historical side of the subject, and between 1775 and 1787 he published five large volumes on the history of ancient and modern astronomy. In addition, in three smaller works he tried to retrace the course of man's development, and supported the theory of a primitive golden age. Although his scholarly works brought him many public honours, not only in France but also in four other European countries, he nevertheless found himself involved in a number of scientific and literary quarrels, largely because of his wild speculations on antiquity. Perhaps it was fortunate that he took part in the investigations of Mesmer's pretensions regarding animal magnetism, because this brought him back into contact with controlled scientific inquiry in which men like Franklin, Lavoisier, Guillotin and others played a prominent part, so that after the autumn of 1784 mesmerism rapidly disappeared from Paris, though it continued to be practised in the provinces.

The study of Newtonian physics led Bailly to the belief that scientific precision could be extended to other fields of human knowledge, such as history, law, language, etc., and this view led to a breach with the sceptical philosophers who had little confidence in systematic explanations of immaterial or intangible phenomena. As the author of this biography remarks, "Bailly fell victim to the hobgoblin of *vraisemblance*", in other words, in cases where truth could not be demonstrated, he was prepared to accept the probable explanation. The French Revolution represented the acid test for Bailly's philosophy, for that was the period when the theorist could try the practical application of his ideas, and Bailly's ideas did not survive the test. At the end of the biography, the author pays a tribute to his public work, in spite of its lack of success. "The remarkable aspect of Bailly's public life is not his failure, but the fact that he succeeded so well in coping with the practical problems which were so far removed from his cognizance".

A DETAILED RADIO MAP OF THE SKY

By Prof. J. D. KRAUS and H. C. KO

Radio Observatory, Department of Electrical Engineering, Ohio State University

From observations during the spring of 1954 with the Ohio State University radio telescope, a detailed radio map of the sky has been made. This map (Fig. 1) has sufficient detail to suggest how the sky would appear if our eyes were sensitive to radio waves instead of light. The central region of our galaxy or Milky Way system stands out prominently, as do also a number of localized radio sources such as Cassiopeia *A* and Cygnus *A*.

The contours are lines of equal radio brightness as observed at 250 Mc./s. with the 96-helix antenna of the Ohio State University radio telescope. The observations were made by setting the antenna at a fixed declination for several days. As the earth rotated, a record or profile of the cosmic radio background was then obtained as a function of right ascension for a narrow zone of declination. Scores of such profiles taken at other declinations were combined to produce the map. The co-ordinates are right ascension (α) and declination (δ) (1950.0) and the contours give the apparent radio brightness in units of 10^{-25} W. m.$^{-2}$ (c./s.)$^{-1}$ deg.$^{-2}$. The map gives the observed levels, not being corrected for the antenna pattern. Thus, a minor lobe of the antenna appears as a small rise near the preceding sides of the strong sources Cassiopeia *A* and Cygnus *A*. The elongated shape of these sources is a direct measure of the antenna pattern, which is a fan-beam 1° wide between half-power levels in right ascension by 8° in declination at 250 Mc./s. The minor lobes and elongated shapes are imperfections in the radio map that are analogous to the defects in an image seen with an optical telescope due to the aberrations of the lens. Since the map is a Mercator projection, a localized source near Dec. 0° such as Virgo *A* appears as a more slender ellipse than does a source more remote from the equator such as Cassiopeia *A*.

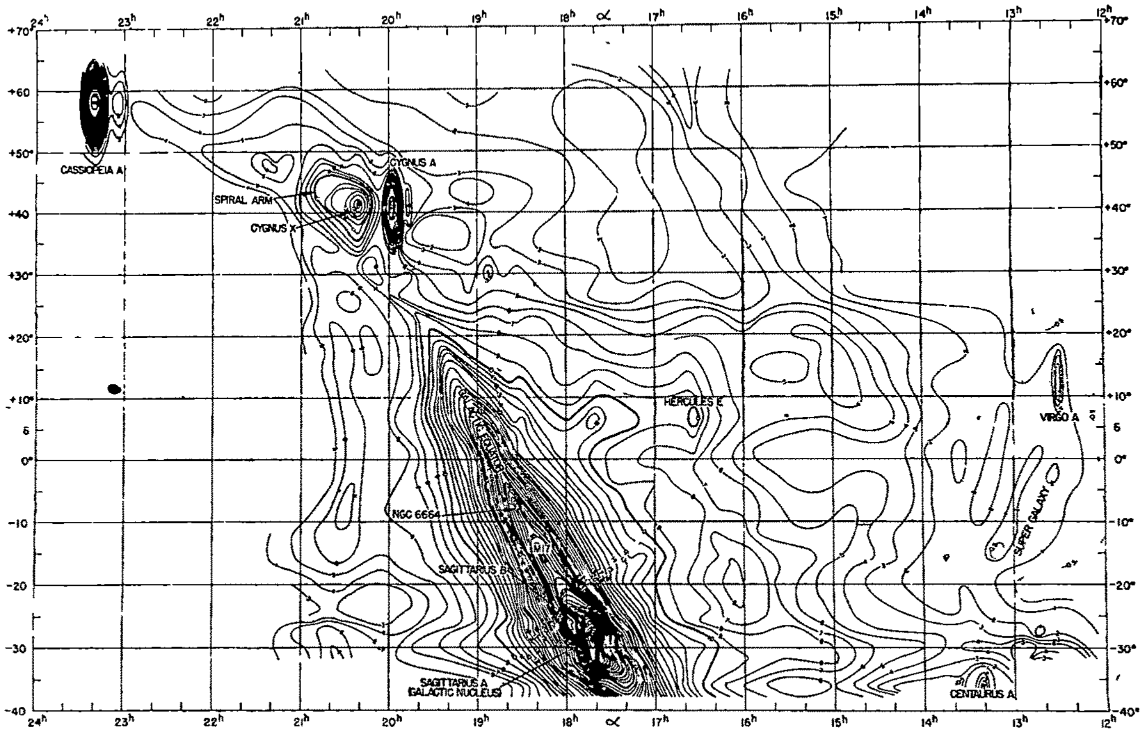


Fig. 1. Map showing the apparent radio brightness of the sky as observed at 250 Mc./s. The contours are lines of equal radio brightness (radio isophotes). Cassiopeia *A*, Cygnus *A*, the central region of our galaxy and its nucleus (Sagittarius *A*) stand out as intense sources. A number of weaker sources are also indicated

Although records were taken continuously, twenty-four hours a day, usually only those obtained during the early morning hours were sufficiently free from interference (solar and terrestrial) to be usable. Thus, the map is restricted to the region between R.A. 12^h and 24^h. The region north of Dec. +65° is not included, due to interference, while that south of Dec. −40° is either close to or below the horizon. Observations are in progress to extend the map to the entire sky observable from Columbus, Ohio, that is, north of about Dec. −40°.

In addition to such well-known sources as Cassiopeia *A* (peak value 46) and Cygnus *A* (peak value 37.5), the map also reveals a number of extended sources such as the one coinciding with the plane of the supergalaxy[1,2] in the region between the localized sources Virgo *A* and Centaurus *A*. The latter source is actually below the lower boundary of the map (at Dec. −43°) but its presence can be deduced from the deviation of the nearby contours.

In constructing the map each profile was arbitrarily adjusted to the same zero or reference-level for all declinations along a line near R.A. $11^h\ 30^m$, the minimum brightness being near this line. Thus, the map may be subject to a slight distortion which would appear chiefly as a small gradient in declination. Also, since the minimum background-level is finite, not zero as assumed, all contour-levels on the map should be increased by this minimum brightness (of the order of 8 map units) in order to give the absolute brightness-level.

Although numerous radio contour maps of the sky have been published, the resolutions have been insufficient to reveal much detailed structure. Two exceptions are the recent maps by Hanbury Brown and Hazard[3] of the Cygnus region and by McGee and Bolton[4] of the region near the galactic centre, both made with 2° × 2° beams. However, both these maps cover only relatively small regions of the sky.

The highest elevation on the map, designated Sagittarius *A*, is presumably the galactic nucleus; it stands out as a sharp spire (peak value 65) superimposed on the general galactic background. The centre of our galaxy is obscured by dust from optical observation, so that a direct observation of the position of the nucleus is of much importance. The equatorial co-ordinates (1950.0) of the galactic nucleus as determined from the map are

$$\text{R.A.}: 17^h\ 42^m\ 48^s \pm 15^s, \quad \text{Dec.}: -28°\ 50' \pm 30'$$

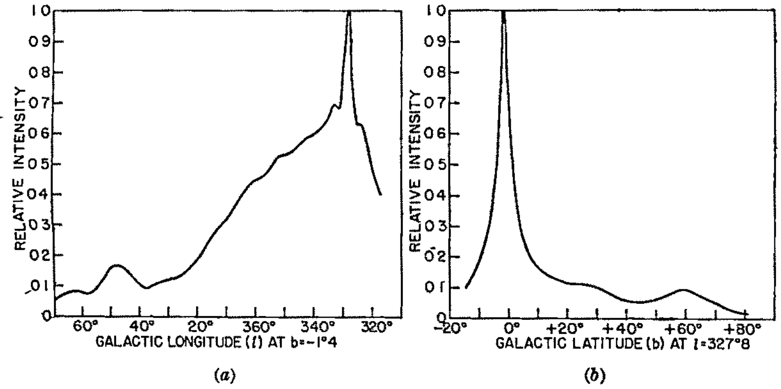
The corresponding galactic co-ordinates (Ohlsson) are

$$l = 327.8°, \quad b = -1.4°$$

Haddock, Mayer and Sloanaker[5], with a $\frac{1}{2}° \times \frac{1}{2}°$ beam at 9.4 cm. wave-length, report a position for this source of $17^h\ 42^m\ 30^s \pm 12^s$ and $-29°\ 01' \pm 5'$. The agreement of the positions is within the error of measurement.

Longitudinal and transverse profiles through the galactic nucleus as obtained from the map are presented in Fig. 2. The ordinates are the relative intensity (or relative brightness). Fig. 2*a* shows the intensity in the plane of our galaxy expressed as a function of galactic longitude at a constant galactic latitude of −1.4°. Fig. 2*b* shows the intensity at right angles to the galactic plane expressed as a function of galactic latitude at a constant galactic longitude of 327.8°.

From the galactic nucleus, which rises as a sharp peak at 327.8°, the longitudinal profile (Fig. 2*a*) has a gradual decrease to about 360° with a somewhat more rapid falling off beyond. This change in slope is probably related to the fact that from about 330° to 360° radiation is observed from the inner spiral arms



(a) (b)

Fig. 2 (a) Longitudinal and (b) transverse profiles through the galactic nucleus showing the observed relative radio intensity as a function of the galactic longitude and the galactic latitude

of our galaxy. From 360° to 40°, and beyond, the direction of observation is outside the inner spiral arms and the intensity falls off more rapidly except for a small peak at about 48°. This peak is presumably caused by radiation from the spiral arm in which we are situated being observed inwardly along the arm.

Fig. 2b reveals the thin structure of our galactic disk as viewed in transverse section. However, residual radio intensity is seen to extend out to large galactic latitudes with small peaks near the galactic latitudes of 30° and 60°.

This work has been supported by grants from the Development Fund, the Lovejoy Memorial Fund, and the Research Foundation of the Ohio State University and also by a grant from the National Science Foundation. [Sept. 29.

[1] Kraus, J. D., and Ko, H. C., *Nature*, 172, 538 (1953).

[2] de Vaucouleurs, G., *Astro. J.*, 58, 30 (1953); *Scientific American*, 191, 30 (1954).

[3] Hanbury Brown, R., and Hazard, C., *Mon. Not. Roy. Astro. Soc.*, 113, 109 (1953).

[4] McGee, R. X., and Bolton, J. G., *Nature*, 173, 985 (1954).

[5] Haddock, F. T., Mayer, C. H., and Sloanaker, R. M., *Astrophys. J.*, 119, 456 (1954); *Nature*, 174, 176 (1954).

POSSIBLE SITE AND MODE OF ACTION OF CERTAIN LIPOTROPIC MACROMOLECULES IN TUBERCULOSIS

By Dr. J. E. LOVELOCK and Dr. R. J. W. REES
National Institute for Medical Research, Mill Hill, London, N.W.7

It has been reported that certain macromolecular detergents are effective chemotherapeutic agents against tuberculous infection in mice[1] and in guinea pigs[2]. More recently, Cornforth, Hart, Nicholls, Rees and Stock[3] have shown that the antituberculous effect is confined to members of these series having a high lipophilic/hydrophilic ratio, and that as this ratio is decreased therapeutic activity is reduced and then reversed, so that the more hydrophilic members actually enhance the infection ('protuberculous' effect). The detergents are prepared by forming the polyoxyethylene ethers of a high molecular-weight condensate of *p-tert*-octyl-phenol and formaldehyde. Unfortunately, these antituberculous compounds cause liver damage in animals after prolonged use and cannot at present be considered for use in man. This discovery, however, has stimulated further studies to determine the site and mode of action.

Cornforth *et al.*[1] showed that the detergents were stable *in vivo* and remained within the circulation of the animals for many days. It appears that the activity is a property of the intact substance and is not due to metabolic products of its breakdown *in vivo*[3]. The agents are neither bactericidal nor hæmolytic *in vitro* even at concentrations as high as 2·0 per cent. It seems, therefore, that their activity depends upon some disturbance of the host–parasite relationship rather than a direct toxic action upon the bacteria. This idea receives support from the observation of Hart, Long and Rees[4] that these therapeutically active detergents produce a definite though limited depression of the tuberculin response in tuberculous and BCG-vaccinated guinea pigs. The first indication of a site of action of these substances came from the experiments of Mackaness[5], who showed that suppression of growth of the tubercle bacillus occurred within the host phagocytic cells. Monocytes from rabbits treated for several days previously with one of the chemotherapeutically active agents readily ingested virulent tubercle bacilli, but in contrast to the monocytes of untreated animals, there was little or no multiplication of the bacteria afterwards. Monocytes from untreated animals were not rendered inhibitory to the growth of ingested virulent organisms by the mere suspension of the phagocytic cells in a solution of detergent *in vitro*.

These last observations encouraged experiments to determine whether or not the antituberculous agents actually penetrate the monocytes *in vivo*, and if so to what concentration, and whether they are free or adsorbed upon the surfaces and structures of the cell. Assuming that the detergents do penetrate the cells and are present free at high concentrations, the possibility arises that they might be rendering the organism vulnerable to the destructive agencies of the phagocyte by stripping or modifying a protective lipid outer layer. Experiments, reported here, upon the action of the different detergents towards the hæmolysis of human red cells by thermal shock have a bearing on this point, for the sensitivity of red cells towards hæmolysis on sudden cooling is strongly dependent upon the composition of the lipids of the cell membrane[6,7].

Site of Action

Monocytes were obtained from the peritoneal cavity of mice 24 hr. after the intraperitoneal injection of 0·2 ml. of a mixture of equal parts of 40 per cent 'Lemco' and 20 per cent gum acacia. The monocytes were harvested by washing out the peritoneal cavity with 1 ml. of heparinized saline containing 2 per cent albumin. An equal volume of 0·01 per cent suspension (containing particles of approximately $1\,\mu$ in diameter) of victoria blue, *B*150, was added to the monocyte suspension, and the mixture was then vigorously shaken and incubated at 37° C. Samples were removed at 5-min. intervals and examined under the microscope either as hanging-drops or in slide-cells. The monocytes examined in this way were obtained from mice treated with one of the antituberculous agents and from untreated control animals.

The cells from both the control and the test animals were observed to have ingested the dye particles freely. After a short time, however, the particles within the test macrophages were seen to dissolve and produce discrete circular patches of blue; later the blue patches merged and the whole cell was coloured uniformly. By contrast, the dye particles within the control macrophages remained intact with no trace of dissolution throughout the course of observation. The quantity of dye taken into solution by the detergent was found, by separate experiments, to be directly proportional to the concentration of detergent over the range 0.001–10 per cent. Assuming that the quantity of dye dissolved by a given concentration of detergent is the same within the cell as it is in the test-tube, it is possible to calculate very approximately from the depth of colour of the cell the concentration of detergent it contains. A saturated solution of the dye in 0.01 per cent of a typical therapeutically active detergent gives a blue colour which is only just visible in a layer 100 μ thick. Assuming the thickness of the macrophage is approximately 10 μ, this suggests that the concentration of the detergent within the cell is at least 0.1 per cent, for the cell was visibly blue and it is not certain that sufficient dye had been ingested to saturate the detergent within it.

These experiments suggest that, not only does the cell contain a high concentration of the detergent, but also that it is uniformly distributed with it and is freely available for the solution of the dye and lipid material ingested by the macrophage.

Mode of Action

The macromolecular detergents under discussion are not tuberculostatic *in vitro*, even at concentrations as high as 2.0 per cent. The properties of tubercle bacilli grown in their presence are, however, altered. Most of these detergents promote dispersed submerged growth rather than the normal granular formation[8]. Virulent strains of tubercle bacilli which normally decolorize methylene blue very slowly in the presence of glucose, using the Thunberg–methylene blue technique, do so rapidly when therapeutically active detergents are added (Rees, unpublished work). These effects suggest that the superficial lipid layers of the organism are somehow modified in the presence of these detergents. This might result either from the adsorption of the detergent on to the surface of the organism, or by the solution of lipids from the bacteria within the detergent micelles.

Red blood cells, like tubercle bacilli, have a predominantly lipid outer layer. It is possible to produce modifications in the quantity and proportion of lipids in the membrane of the red blood-cell without causing irreversible damage[6]. Thus the red blood-cell can lose as much as 20–30 per cent of its lipids without hæmolysis. Therefore, although the detergents under consideration are not hæmolytic even at concentrations as high as 2.0 per cent and for periods of exposure as long as 1 hr. at 37° C., this absence of hæmolysis does not necessarily indicate that the cells are unaffected by the exposure. The most simple and sensitive method of determining reversible changes in the lipid composition of the red cell membrane is to observe their sensitivity to thermal shock, that is, hæmolysis on sudden cooling, which is directly related to the proportion of cholesterol to phospholipid in the red cell membrane[7]. The removal of lecithin from the cell increases, and the removal of cholesterol decreases, sensitivity to hæmolysis by sudden cooling. This system thus offers a convenient test for the effect of the different detergents upon the lipid membrane of the red cell and for comparing any such effect with that upon tuberculous infection.

A 10 per cent suspension of human red cells in 0.16 *M* sodium chloride was incubated at 37° C. for 1 hr. with concentrations of the detergents ranging from 0.05 to 10.0 mgm. per ml. At the end of this time an equal volume of 2.4 *M* sodium chloride, also at 37° C., was added to the suspension. After a further 5 min. at 37° C., the tube containing the cells was transferred to a mixture of crushed ice and distilled water and there left for 10 min. The chilled suspension was centrifuged, and the extent of hæmolysis measured in terms of the light absorption of the hæmoglobin released into the supernatant.

Fig. 1 shows the effect on thermal shock of one series of detergents, which were all derived from the same parent resin (*p-tert*-octyl-phenol formaldehyde resin) and are designated by the average number of ethylene oxide units added to each phenolic hydroxyl group of the resin. In the absence of any detergent, 50 per cent of the cells were destroyed by thermal shock. The detergents with ten or twenty ethylene oxide units considerably decreased, whereas the one with thirty units slightly decreased, the severity of the damage by cooling at the lower concentrations used. The detergent of this series with sixty ethylene oxide units increased the damage by thermal shock at all concentrations, and that with ninety units of ethylene oxide only slightly increased the damage. On the other hand, a polyethylene glycol with a molecular weight of 4,000 had practically no effect upon thermal shock.

These results demonstrate that the surface of the red cell is modified after exposure to the detergents. Their interest becomes greater, however, when they are compared with the activity of the detergents

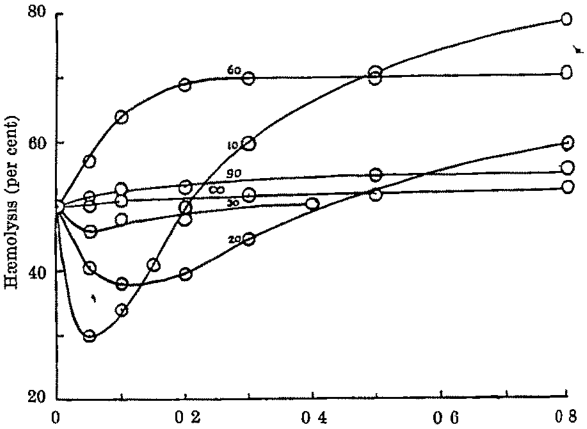


Fig. 1. Effect of exposure for 1 hr. at 37° C. to a homologous series of detergents upon the sensitivity of red cells in 1.2 *M* sodium chloride to hæmolysis by sudden cooling from 37° to 0° C. The detergents tested had 10, 20, 30, 60 or 90 ethylene oxide units per phenolic hydroxyl group. Polyethylene glycol, molecular weight 4,000, is included also to represent a detergent with an infinite number of ethylene oxide units

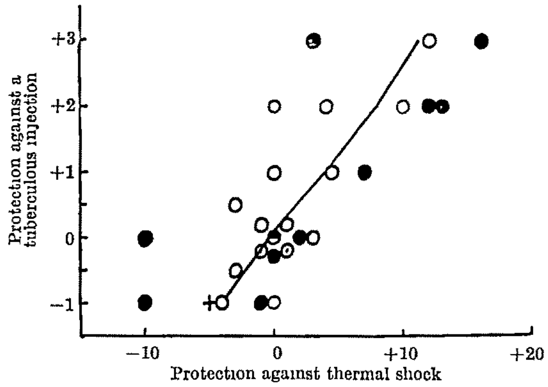


Fig 2 Comparison of the effect of various agents upon the sensitivity of red blood-cells to thermal shock (expressed as percentage change in sensitivity at a detergent concentration of 0 1 mgm /ml) and upon a tuberculous infection in mice The detergents tested included those derived from a linear macromolecule of *p-tert*-octyl-phenol formaldehyde condensate (●), a macrocyclic tetramer of the same condensate (○), suramin (+) and a block copolymer of ethylene and propylene oxides ('Pluronic *F*68') (◓) The curve shows the mean activities towards thermal shock in red cells for each class of activity towards infection

towards infection with tuberculosis *in vivo* The detergents with ten and twenty units of ethylene oxide are both antituberculous, the one with thirty units is inactive and the detergents with sixty and ninety units are 'protuberculous'. The polyethylene glycol is inactive Thus there is a broad correlation between the activity of the detergents towards thermal shock *in vitro* over the concentration range 0–0 2 mgm /ml and their activity towards infection.

Fig 2 compares the activities of twenty-five macromolecular detergents both towards infection with tuberculosis and thermal shock in red blood-cells Mice are infected intravenously with a virulent human strain of *Myco tuberculosis* (*H*37*Rv*) and treated intravenously with the agents on the first, fourth and eighth days after infection The effect of each agent on the course of infection is assessed from the median survival times in the treated and control groups, and its effect in preventing or enhancing infection is finally graded as an arbitrary score between + 3, 2 or 1 (antituberculous), inactive (0) and ('protuberculous') − 1, respectively. The effect in reducing or increasing thermal shock was measured by the technique already described The results shown in Fig 2 are the hæmolysis after thermal shock in 1 2 *M* sodium chloride following exposure for one hour at 37° C. to 0 1 mgm of detergent per ml. of solution Another type of macromolecular detergent, a block copolymer of ethylene and propylene oxides, 'Pluronic *F*68' (Wyandotte Co , Michigan), and a negatively charged high molecular-weight substance, suramin (urea derivative of the aminonaphthalene-sulphonic acid series), are also included for comparison. The block copolymer is inactive in both systems Suramin, on the other hand, has been shown to enhance a tuberculous infection in mice (Hart and Rees, unpublished work) This substance remains intact within the circulation for long periods, and furthermore it is concentrated in monocytes[9]. It is therefore of considerable interest that this substance is active in both our systems, enhancing a tuberculous infection and increasing the sensitivity of red blood-cells to thermal shock

Discussion

The experimental evidence suggests that the detergents are concentrated *in vivo* within the monocytes and that they are present within the cells in sufficient concentration and in a suitably free condition to 'solubilize' lipids ingested by the cell The correlation between the activities of the different detergents towards thermal shock in red cells and towards infection with tubercle bacilli suggests that the activity of the detergents is connected with their ability to modify the membrane lipids of the organism while it is within the macrophage Some light on the possible changes which could occur in the membrane lipids of the tubercle bacillus also comes from the experiments with red cells

The behaviour of the detergents towards red cells is consistent with the notion that the detergents with few ethylene oxide units adsorb or displace cholesterol preferentially from the membrane of the red cell, and detergents with many ethylene oxide units adsorb or displace phospholipid preferentially from the envelope of the red cell This is because the sensitivity of the cell to thermal shock is proportional to the ratio of cholesterol to lecithin in the cell membrane. Preliminary chemical analysis of the lipids of the red cell after exposure to the detergents also lends support for this notion

If the detergents affect the tubercle bacilli and red cells in an analogous manner, then it might be expected that the detergents with few ethylene oxide units per molecule would remove or displace the more hydrophobic lipids of the organisms preferentially This would conceivably render the bacteria more sensitive to digestion within the phagocytic cells The 'protuberculous' activity of the detergents with sixty ethylene oxide units could in a like manner be due to the removal of displacement of the more hydrophilic lipids preferentially, thus rendering the lipid layer of the bacterium even more resistant and impermeable than it is normally These ideas are also supported by the observation that the character of growth and permeability of the organism are changed in the presence of the detergents.

These suggestions are put forward tentatively to provide a working hypothesis for testing other substances It is realized, of course, that even if the suggestions are correct there are other ways in which the host–parasite relationship could be altered by the presence of macromolecules within the phagocytic cells , for example, the suppression or enhancement of enzymic activity of the cell or parasite or both

Whatever is the precise mechanism of action of these agents, it seems very probable that their activity is primarily dependent upon their ability to become concentrated within the monocyte cells, which are themselves known to play an important part in the natural infection

We are indebted to Dr P D'Arcy Hart for his interest and advice , to Dr J W. Cornforth and Dr G A. Nicholls for preparing the series of detergents , and to Imperial Chemical (Pharmaceuticals), Ltd , for the victoria blue *B*150 [Oct 1

[1] Cornforth, J W , Hart, P D'Arcy, Rees, R J W , and Stock, J A , *Nature*, **168**, 150 (1951)

[2] Rees, R J W , *Proc Roy Soc Med* , **46**, 581 (1953)

[3] Cornforth, J W , Hart, P D'Arcy Nicholls, G A , Rees R J W , and Stock, J A *Brit J Pharmacol* (in the press)

[4] Hart, P D'Arcy Long, D A , and Rees, R J W , *Brit Med J* , (i), 680 (1952)

[5] Mackaness, G B , *Amer, Rev Tuberc* , **69**, 690 (1954)

[6] Lovelock, J E , *Nature*, **173**, 659 (1954)

[7] Lovelock, J E , *Brit J Haematol* (in the press)

[8] Rees, R J W , and Hart, P D'Arcy, *J Gen Microbiol* , **7**, 372 (1952)

[9] Jancsó, N , and Jancsó-Gábor, A , *Acta Physiol Acad Sci Hung* , **3**, 537 (1952)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Use of Electronic Digital Computers in Optical Design

ELECTRONIC digital computers in Britain and the United States have been used for the tracing of rays at high speeds through optical systems. The larger machines have enough auxiliary storage, either magnetic drum or tape, to accommodate enormous amounts of information, so that it is possible to carry out extensive numerical investigations concerning lens systems.

During the past year, experiments have been carried out using the University of Manchester electronic computer in the automatic design of optical systems. The optical design problem has been regarded as a minimization problem of a single function φ, which has been called the performance function, with respect to the variable constructional parameters of the system.

The problem is a special one in that the variable-function system is largely ill-conditioned and non-linear, but is less extensive than the general problem because the *n*-dimensional surface concerned has certain known properties due to its optical nature. The performance function φ has been constructed by summing the squares of the maximum moduli of certain blocks of aberration residuals with appropriate scaling or weighting factors. Performance numbers of this sort have no optical significance whatever; they simply relate to the state of the geometrical aberration residuals at points in the minimization process. The precise nature of the function φ does, of course, determine the distribution of residuals at the conclusion of any minimization process; but its nature becomes less important as the calculated residuals become smaller.

Until the present time four principal machine minimization processes have been employed. They are iterative within themselves and iterative with respect to each other. The processes are briefly as follows:

(*a*) *Variable-by-variable minimization.* Here variables are taken singly and adjusted by adding or subtracting small increments to each in turn. The large auxiliary storage of the Manchester machine allows one to store all inter-surface ray-tracing data, so that if a parameter in the middle of a system is altered, the ray-tracing data immediately preceding the altered parameter are 'picked up' and the performance number evaluated very rapidly. If a change in a variable results in an increase in φ, then the sign of the increment is changed and φ recalculated. Should the value of φ fall on any parameter change, then the new value of the parameter is retained and control moves to the next variable in the block or series.

Variable-by-variable minimization is extremely rapid (a 'run' on the surface curvatures of a 'Tessar' takes about twenty minutes machine time), and can be regarded as the basic unit relaxation process of automatic design.

(*b*) *Block relaxation.* What is required at the close of the variable-by-variable process is a method of altering the refraction conditions associated with each variable while the general composition of the system is appreciably unaltered, so that the variable-by-variable process can continue with advantage.

Lens 'bending' can be likened to a block operation of numerical relaxation, it being effected by adding (or subtracting) small equal increments to the surface curvatures of a given lens. In optics, however, the increment is chosen with the particular purpose of improving the overall distribution of residuals.

Automatic block operations can be carried out automatically on from two to *n* variables with two purposes in mind, namely, to reduce the latest value of φ directly, and to change the refraction conditions associated with each variable.

A particularly useful optical block operation is that made by adding small equal increments to all variable parameters, so that the system receives a 'kick' in a certain direction. Throughout this operation and the following operations described, attention must be paid to the configuration of the rays. If the nodal points of the system are taken as reference points, then after each block operation these must be redetermined so that the extra axial rays pass through all systems in a constant manner. In this way only will the resultant values of φ be strictly comparable.

(*c*) *Group operations.* In some cases the variable-by-variable method followed by various block operations leads to an optical system which has a set of residuals all less than those of the original or some intermediate system. It is a simple matter in these circumstances to carry out an optical group operation which is in fact an extrapolation from two systems to a third (usually) better system, that is, to a system which has a still lower value of φ. Group changes can always be made with advantage unless the present lowest value of φ is at a true topographical minimum.

Since the number of variables changed in group operations is considerable and the individual increments generally small, the relation between the extent of the operation and the change in the residuals is largely linear. This fact allows one to 'forecast' a set of residuals without actually calculating them by precise ray-tracing—provided that all 'reference' systems have constant focal length, and an exactly similar ray configuration.

(*d*) *Random operations.* The Manchester machine has a useful facility by which a series of twenty random binary digits are produced by a noise generator; using certain logical instructions, it is possible to add (or subtract) increments to a completely random selection of variables. Should the same parameter be selected *p* times, then that particular parameter receives *p* equal increments. If the value of φ is already low, the general tendency of this random process is to increase φ. The main advantage of increasing φ by random methods is that systems can be evolved for use in group relaxation methods already mentioned. The random process is in fact used for testing whether or not the latest lowest value of φ is in fact a true topographical minimum value.

A programme which incorporates all these methods has been used with success at Manchester. Considerable improvement has been achieved on a 'Tessar' lens which has been in use for many years. The improvement was carried out in a little more than two hours.

It is hoped that a full account of this work will appear elsewhere. I am grateful to the Ministry of Supply for permission to publish this work; thanks are due to the Director and Council of the British

Scientific Instrument Research Association, under the auspices of which the work was conducted, under contract to that Department Thanks are due to those physicists and mathematicians with whom I have enjoyed stimulating discussion, notable among whom are the late Dr A M Turing, Mr Brooker and Dr. Hoskin, of the University of Manchester, Dr. H H Hopkins, of the Imperial College, London, and Mr Bracey, of the above Association

GORDON BLACK
Computing Machine Laboratory,
University, Manchester 13 Nov 25

An Interpretation of the Long-Spacing Intensities of Calcium Stearate Monohydrate

THE interpretation of powder patterns of soaps and other long-chain aliphatic compounds which cannot be obtained as single crystals is not easy and is usually ambiguous[1] Samples of calcium stearate monohydrate prepared by D Wallace using the method of Vold, Hattiangdi and Vold[2] were recrystallized from solution in a mixture of propylene glycol and chloroform. The recrystallized soap was in the form of very tiny laths which could be formed into highly orientated sheets by sedimentation or by flotation Such a specimen, mounted on a glass plate, used in a Geiger-counter diffractometer, gives rise to the long-spacing peaks of spacing $d = 50\ 30$ A from planes parallel to the plane of the specimen and no other peaks

The intensities of the reflexions were measured to order 30 No reflexions were found beyond this, although observations were continued beyond order 40 The higher-order reflexions were weak and digital counting was necessary for detecting and measuring them. The intensities, corrected for geometrical factors and sharpened, were used to calculate the linear Patterson function This showed a prominent group of peaks centred at 17 A from the origin, probably indicating that in the structure there are two molecules separated by 17 A more or less parallel to their length This model, assuming that the projection on the long-spacing axis is centrosymmetric, was used for the calculation of structure factors and the corresponding Fourier projection The Fourier projection was refined using a semi-quantitative difference method[3], and it was soon evident that the position of the water molecule, in projection, must be the same as that of the calcium atom The final observed and calculated Fourier projections are shown in Fig 1(*a*) and the corresponding suggested molecular arrangement in Fig 1(*b*) Apart from the 'hole' at $z = \frac{1}{2}$ which is not present in the calculated Fourier projection, the agreement is good The principal peaks and the trough at $z = 0\ 32$ corresponding to the end of the molecule are satisfactorily reproduced in both projections

The nature of the proposed structure with two molecules separated by 16 8 A. parallel to their length restricts ionic bonding between molecules to one direction only, unlike the two-dimensional ionic sheets observed in the soaps of monovalent metals

The powder pattern can be indexed tentatively as a monoclinic unit cell using the methods of Vand[4], with $a = 5\ 70$ A, $b = 6\ 81$ A, $c = 50\ 4$ A, $\beta = 94°$ and possible space group $P2_1$ The observed and calculated densities are 1 07 and 1 04 gm cm^{-3} respectively

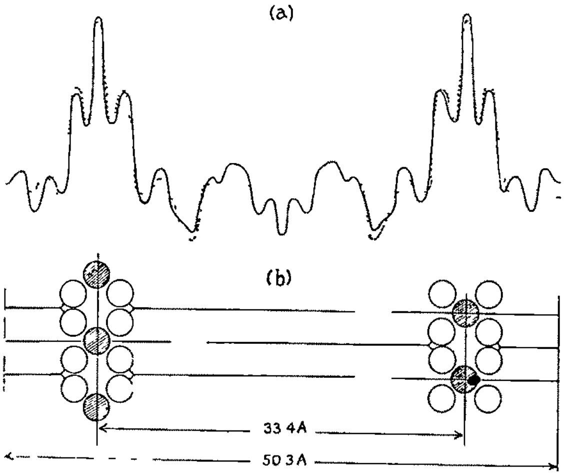


Fig 1 (*a*) Fourier projection on the long-spacing axis the continuous line is obtained using the observed structure factors the broken line using the calculated structure factors

(*b*) Possible type of structure corresponding to Fig 1 (*a*) Calcium atoms, oxygen atoms and hydrocarbon chains are represented by shaded circles, open circles and straight lines respectively The water molecules have not been included in the diagram

The direction of the ionic bonding may be that of the *a*-axis, which is similar in length to the *b*-axis found by Vand, Lomer and Lang[5] in potassium laurate. The molecular cross-section of 19 8 A^2 is greater than in potassium and silver soaps This may be due partly to the restriction of the ionic bonding to one direction.

This work was supported by the U S Office of Ordnance Research under contract *D A.* 04–495 *ord*303 I am grateful to Drs M J Vold and R D Vold for the many stimulating discussions during the course of the work, which was done during the tenure of a Fulbright Travel Grant and a University of Southern California Fellowship.

E STANLEY[*]
Chemistry Department,
University of Southern California,
Los Angeles 7 Aug 30

[*] Present address Division of Physics National Research Council, Ottawa, Canada

[1] Buerger, M J, *Proc U S Nat Acad Sci*, 31, 226 (1945)
[2] Vold, M J, Hattiangdi, G S, and Vold, R D, *J Coll Sci*, 4, 93 (1949)
[3] Cochran, W, *Acta Cryst*, 4, 408 (1951)
[4] Vand, V, *Acta Cryst*, 1, 109 and 290 (1948)
[5] Vand, V, Lomer, J R, and Lang, A, *Acta Cryst*, 2, 214 (1949)

Formation of Compact Pieces of Grey Tin

IN a recent communication on this subject, Groen[1] described a method of preparing large pieces of grey tin by transforming an alloy of tin containing about 2 atomic per cent of mercury Experiments have been proceeding in this Department with the same end in view, and the purpose of this communication is to describe a possible explanation of this result

In pure tin, the β–α transformation results in the formation of grey tin as a friable powder This condition is the result of cracks, arising during the volume expansion associated with the formation of the α-(grey) tin phase Examination of partially transformed specimens has shown that the cracks may be classified into two groups The first group appear between the islands of grey tin, the second group appear in an irregular manner within the islands themselves The first type of crack can be explained on the assumption that grey tin is mechanically weaker than the white, when two islands of the α-phase meet on the surface, the next layers to be transformed just beneath the surface lever the two islands apart

Microscopic examination of the surface of a partially transformed specimen reveals that each island of α-tin is surrounded by an extensive field of slip lines and kink bands, again due to the surface stresses resulting from the volume expansion The density and coarseness of the slip lines increase as the transformation proceeds, and result in macroscopic buckling of the specimen Since the grey tin is keyed to the α–β boundary, this buckling causes fracture of the weaker α-phase

This second type of crack formation may be suppressed by raising the yield stress of the β-phase, and the most convenient way of doing this is by alloying Indentation hardness tests at room temperature showed that whereas the Vickers Pyramid Hardness number of pure tin was 6 7, that of an alloy containing 2 weight per cent of mercury was 19 8 When this specimen was transformed, few slip lines were observed, and buckling was absent. Cracks of the first type still appeared between the islands, these cracks cannot, of course, be suppressed by this means, but the individual islands were strong and compact. Other alloys with a suitable strength should yield the same result

E. O Hall

Physics Department,
University of Sheffield.
Dec 1.

[1] Groen, L J, *Nature*, **174**, 836 (1954)

Structural Breakdown of Cement Pastes at Constant Rate of Shear

For the thixotropic breakdown of materials with time at constant rate of shear, Weltmann[1] proposed the law

$$B = -(\mathrm{d}U/\mathrm{d}t)\,t, \qquad (1)$$

as a result of her work with a rotation viscometer In this equation U is plastic viscosity, t is time from the start of the experiment and B is the coefficient of breakdown with time

Green and Weltmann[2] extended this work and proposed that the thixotropic properties of a material be measured in terms of the three quantities B, M and V, where M is the coefficient of thixotropic breakdown with rate of shear and V measures the change in yield value with decreasing plastic viscosity V is expressed as

$$V = -\mathrm{d}f/\mathrm{d}U, \qquad (2)$$

where f is yield value, but Shapiro[3] has shown that V is simply the value of the rate of shear corresponding to the point of intersection of the various down-curves

It may be shown[4] that under the conditions of Green and Weltmann's experiments, where the rate of shear in a rotation viscometer was increased in equal small steps at equal intervals of time, the constants M and B are one and the same Further, all the equations derived theoretically by Green and Weltmann may be obtained from Weltmann's law alone, without making any further assumptions

If yield value is considered to be constant (which was found to be the case by Weltmann, at constant rate of shear), Weltmann's equation may be integrated and written for the rotation viscometer as

$$T = -B \ln t + \text{constant}, \qquad (3)$$

at constant rate of shear and where T is the torque at time t.

In experiments with a rotation viscometer on the structural breakdown of Portland cement/water pastes at constant rate of shear, I have found[4] that this equation agrees with experiment only over a limited range of torques, points taken after a few seconds deviating widely from it For cement pastes, the decrease in torque can be well represented by the equation

$$T = T_E + (T_0 - T_E)\exp(-B't), \qquad (4)$$

where T_0 and T_E are the initial and equilibrium torques This equation is superior to Weltmann's in fitting the experimental results and has the additional merit of giving a meaning to values of T for $t = 0$ and $t = \infty$ which Weltmann's equation fails to do

In Weltmann's results, her plot of T as a function of $\ln t$ inevitably ignores the value for $t = 0$, and in the case of a pigment suspension D for which she gives full results[1], the next point, for $t = 7$ sec, does not fall on the line The first point which is approximately on the line, at $t = 16$ sec, occurs when 70 per cent of the total drop in torque has already taken place A plot of $\ln(T - T_E)$ against t, on the basis of equation (4), gives two intersecting straight lines Similar results are obtained by plotting Weltmann's results on oils[5] by this method, whereas using her method gives curves of various shapes.

Equation (4) may be derived theoretically[4] by considering the work done in a rotation viscometer and making the assumption that the 'excess torque' $T - T_E$ is proportional to the number of linkages existing According to this theory,

$$B' = (2\pi K\omega^2)/\varphi, \qquad (5)$$

where ω is the average rate of shear, φ is the work done in breaking a single link and $K\omega$ is the constant of proportionality between $T - T_E$ and the number of linkages. It follows that B' is a linear function of ω^2 The experimental results were found to conform fairly well to this prediction They were not adequate to determine the dependence of the constant $(2\pi K)/\varphi$, and hence of φ, on the concentration of the paste, but further work is being done on this point.

In this theory no account was taken of any tendency for a rebuilding of the structure, and it was found that for cement pastes there is no such tendency, at least in a time of the order of that taken for an experiment In this respect this material differs from those with which Weltmann worked, and it cannot be classified as thixotropic

G H Tattersall

Research Committee for the
Cast Stone and Cast Concrete Products Industry,
105 Uxbridge Road,
Ealing, W 5
Aug 20

[1] Weltmann, R N, *J App Phys*, **14**, 343 (1943)

[2] Green, H, and Weltmann, R N, *Indust Eng Chem* (*Anal Ed*), **15**, (3), 201 (1943), **18**, (3), 167 (1946) Green, H, "Industrial Rheology and Rheological Structures" (Wiley and Chapman and Hall, 1949)

[3] Shapiro, I, *J Amer Chem Soc*, **68**, 2122 (1946)

[4] Tattersall, G H, M Sc thesis, University of London (1954)

[5] Weltmann, R N, *Indust Eng Chem* (*Anal Ed*), **15**, (7), 424 (1943)

Benzoin as a Fluorescent Reagent for the Detection of Germanium

RECENTLY, we[1] have described a fluorometric method for the detection and determination of germanium, making use of resacetophenone in sulphuric acid or phosphoric acid medium. The test is quite specific, except for the interference of boron. In view of the similarity of the germanic and boric acids thus found, we have investigated the use of other reagents which form fluorescent compounds with boric acid. The reagents described in the literature are flavonols[2], 1-amino-4-hydroxy anthraquinone[3], O-hydroxy carbonyl compounds[4] and benzoin[5]. Among the many compounds tested by us the following have been found to be definitely useful: (1) ω-methoxy resacetophenone, phloro-acetophenone, 4-methoxy-2-hydroxy-benzaldehyde, β-resorcylic aldehyde and salicylaldehyde, which give a greenish-yellow fluorescence; (2) 2-methoxy-3 : 6 dihydroxy acetophenone, 2-benzoyl-phloroglucinaldehyde and 4-methoxy-2-hydroxy-benzoic acid, which give a yellow fluorescence; (3) β-resorcylic acid, orsellinic acid and ethyl orsellinate, which give a violet fluorescence with germanic acid in concentrated sulphuric acid medium.

We have observed that the benzoin reagent described by White and Neustadt[5] for borate also functions as a very sensitive reagent for the fluorometric detection of germanate. It is noteworthy that germanate gives with the benzoin reagent an intense greenish-yellow fluorescence, whereas borate is reported to give a greenish-white fluorescence, beryllium a yellow-green fluorescence and antimony a purplish fluorescence. Zinc gives a green fluorescent compound with benzoin only in the presence of magnesium ions and sodium hydroxide. No other metal or anion is found to give fluorescent compounds with the benzoin reagent. We have found that nitrite, chromate and arsenate quench the fluorescence, whereas silicate somewhat intensifies the fluorescence. Fluoride and nitrate, which quench the fluorescence of germanic acid with the resacetophenone reagent previously described by us, have no effect on the fluorescence with the benzoin reagent.

The fluorescence test with the benzoin reagent is carried out as follows. A saturated solution of recrystallized benzoin in rectified spirit is prepared by shaking an excess of the substance with the solvent at room temperature (28° C.) and filtering; to 5 ml. of this reagent in a quartz test-tube is added 1.0 ml. of a slightly alkaline solution of germanate solution and the mixture made up to 10 ml. with the addition of more rectified spirit. Then the quartz test-tube is exposed to the filtered ultra-violet light from a 'Cenco' black-light source operated on 220 volts a.c. mains. A greenish-yellow fluorescence is observed even when germanium is present in an amount of 10γ. The limit of sensitivity has been found to be 1 100,000. It is evident that the benzoin reagent is more sensitive than the resacetophenone reagent previously described by us. Moreover, benzoin is a reagent easily available, and the method involves its use in alcoholic solution, which is more convenient to handle than the concentrated sulphuric acid medium required for resacetophenone.

We have also observed that the germanate fluorescence with the benzoin reagent persists even after two hours, unlike the borate fluorescence which is described as lasting only for a few minutes by White and Neustadt. The solution, however, acquires a yellow colour on keeping. The benzoin reagent offers possibilities for the fluorometric determination of microgram quantities of germanium.

N. APPALA RAJU
G. GOPALA RAO

Chemical Laboratories,
Andhra University,
Waltair, India.
Sept. 28

[1] Appala Raju, N., and Gopala Rao, G., *Nature*, **174**, 400 (1954).
[2] Tanboeck, K., *Naturwiss.*, **30**, 439 (1942).
[3] Radley, J. A., *Analyst*, **69**, 47 (1944).
[4] Neelakantam, K., and Row, L. R., *Proc. Ind. Acad. Sci.*, **16** A, 349 (1942).
[5] White, C. E., and Neustadt, M. H., *Indust. Eng. Chem. (Anal. Ed.)*, **15**, 599 (1943); **19**, 803 (1947).

Chemical Properties of a Plasma Factor accelerating Hæmoglobin Recovery in Bled Rabbits

IT has been shown that plasma of repeatedly bled rabbits—referred to here as 'anæmic plasma'—contains a factor (or factors) which accelerates the recovery of hæmoglobin concentration after a standard hæmorrhage[1] and produces a greater reticulocyte response in receptor animals[2]; when injected repeatedly into normal rabbits, 'anæmic plasma' significantly increases the hæmoglobin concentration, red cell and reticulocyte counts[3]. After boiling 'anæmic plasma' at pH 5.5, the supernatant, separated from the precipitated proteins, is inactive[1].

In this communication we present data showing that the factor responsible for the activity of 'anæmic plasma' can be extracted from the heat-coagulated plasma proteins, with either water or acetone, and we describe some of the steps taken to purify it.

Rabbits were used as experimental animals. The extracts were tested for activity by their effect on the speed of hæmoglobin recovery[1] after a standard hæmorrhage (1 per cent of body-weight). All extraction processes were carried out in an atmosphere of carbon dioxide, as it is possible that oxygen diminishes the activity of 'anæmic plasma'[1].

Fig. 1 shows the recovery from a standard hæmorrhage of rabbits injected with isotonic sodium chloride, normal rabbit plasma, water extract and acetone extract of the coagulated proteins of 'anæmic plasma'. The acceleration of the recovery of hæmoglobin concentration in animals injected with the extracts of anæmic plasma can be noted; the difference from the controls is statistically significant ($P < 0.01$).

Using the same biological test, we have been able to show that the factor in 'anæmic plasma' can be dialysed through 'Cellophane'; that oxygen diminishes the activity of acetone extracts; that the active portion of the dried acetone extracts taken up in chloroform and passed through a standardized alumina column is retained in the top third, whence it can be extracted with acetone. It is possible to repeat the chromatography on columns three times without loss of activity. The active factor in the acetone extracts can be precipitated from aqueous solution with basic copper carbonate, and it is possible to recover the activity from the precipitate by chloroform extraction. It has also been noted that the active factor of 'anæmic plasma' is carried down with both the albumin and globulin fractions after treatment with ammonium sulphate.

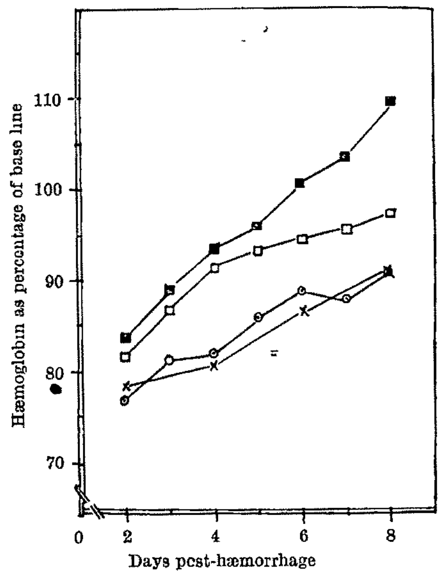


Fig 1 Mean values for hæmoglobin concentration as a function of time, after a standard hæmorrhage (1 per cent body-weight), in the following groups ×——×, 14 rabbits injected with isotonic sodium chloride, ○——○, 16 rabbits injected with normal rabbit plasma, ⊡——⊡, 9 rabbits injected with water extract of 'anæmic plasma', ■——■, 4 rabbits injected with acetone extract of 'anæmic plasma'

The purified acetone extract of 'anæmic plasma' shows (Fig 2) an absorption spectrum in the ultra-violet, similar to that of the extract of 'anæmic urine' It is interesting to note that exposure to oxygen—which diminishes the activity of the extract—changes the ultra-violet absorption spectrum notably However, further chemical purification is necessary before it can be determined whether the ultra-violet absorption spectrum is characteristic of the active factor in 'anæmic plasma' or is due to impurities

Preliminary chemical studies, carried out on purified acetone extracts, show that these only give a positive colour reaction with sudan IV (fatty acid esters) and negative reactions with ninhydrin (amino-acids), mercuric nitrate reagent (purines), and ammoniacal silver nitrate (sugars) on Whatman No 1 paper

Our observations suggest that the factor isolated from 'anæmic plasma' is not identical with the 'erythropoietic hormone' isolated by Contopoulus *et al*[4] from sheep anterior pituitary, which is probably a polypeptide

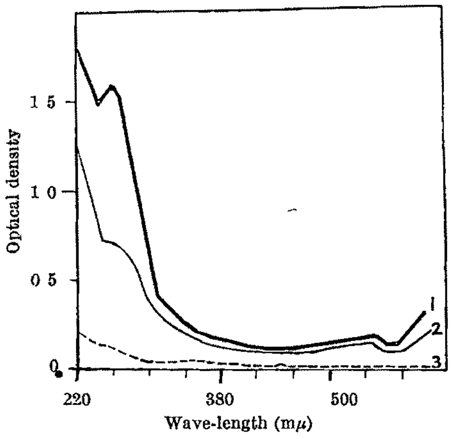


Fig 2 Ultra-violet absorption curve of purified acetone extract of 'anæmic plasma', curve 1 before, and curve 2 after, exposure to oxygen Curve 3 refers to a blank experiment

Further details of the extraction processes and results of the biological tests will be published elsewhere. This work was aided by a grant from the Consejo de Investigación Científica de la Universidad de Concepción We thank Messrs A. Fernández and H Varela for technical assistance

J. Tohá
I Eskuche
F Abarca
F. Salvatore
G Hodgson

Department of Physiology,
University of Concepción,
Cas 44, Concepción, Chile

---

[1] Hodgson, G , and Tohá, J , *Blood*, 9, 299 (1954)

[2] Gunther, B , Hodgson, G , Tohá, J , and Quappe, O , *Acta Physiol Latinoamer* , 1, 271 (1951)

[3] Toha, J , Hodgson, G , and Weasson, E , Proc Fourth Int Cong Int Soc Hematology, 58 (Grune and Stratton, New York, 1954)

[4] Contopoulus, A N , Van Dyke, D C , Simpson, M E , Garcia, J F , Huff, R L , Williams, B S , and Evans, H M , *Blood*, 8, 131 (1953)

Reconstruction of Coupled Phosphorylation in the Succinic Oxidase System

Calcium ions are known to inhibit oxidative phosphorylation in isolated mitochondria As reported previously[1], in the case of substrates oxidized via diphosphopyridine nucleotide, this inhibition can be reversed by the addition of the pyridine nucleotide, adenosine triphosphate and manganous ions Treatment with the pyridine nucleotide alone partially restores only the respiration, but addition of all three factors is necessary in order to re-establish both oxidation and phosphorylation

The phosphorylation accompanying the oxidation of succinate to fumarate is likewise inhibited by calcium treatment, but, since pyridine nucleotides are not involved in this reaction, the oxidation does not become dependent on the addition of the co-enzyme Calcium treatment thus produces a mitochondrial system catalysing the single-step oxidation of succinate. The addition of adenosine triphosphate and manganous ions to such a system results in a coupled phosphorylation at a phosphorus to oxygen ratio (moles of esterified phosphate to atoms of oxygen consumed) of about unity.

Mitochondria were obtained from rat liver, homogenized in sucrose–versene (0 25 and 0 01 M, respectively) and washed once with the same solution The preparation from one liver was suspended in 20 ml of a saline-buffer solution (pH 7 5) containing potassium chloride, potassium phosphate, adenylic acid and glucose, in concentrations specified in Table 1. The suspension was supplemented with yeast

Table 1 Effect of Calcium Ions on the Oxidation of Different Substrates in Rat Liver Mitochondria

Each Warburg vessel contained substrate, 30 micromol , orthophosphate, 76 micromol , adenylic acid, 5 7 micromol , glucose, 200 micromol , potassium chloride, 230 micromol , magnesium chloride, 10 micromol , yeast hexokinase (prepared and diluted as described in ref 1), 0 1 ml , calcium ions (where indicated), 1 15 micromol pH 7 5 Final volume, 2 5 ml Gas phase, air Temp , 30° C Substrate added from side-arm after 5 min of incubation Total incubation time, 29 min

Substrate	Respiration (microatoms oxygen)	
	Calcium ions absent	Calcium ions present
α-Ketoglutarate	24 6	2 3
Succinate	28 7	21 7
Fumarate	12 4	1 0

Table 2. EFFECT OF ADENOSINE TRIPHOSPHATE AND MANGANESE IONS ON PHOSPHATE ESTERIFICATION COUPLED TO THE OXIDATION OF SUCCINATE TO FUMARATE IN RAT LIVER MITOCHONDRIA TREATED WITH CALCIUM IONS

Experimental conditions as in Table 1. Succinate (30 micromol.), adenosine triphosphate and manganese ions added from side-arm after 5 min. incubation. Total incubation time, 25 min.

Additions at 0 time	Additions after 5 min.		Phosphorus to oxygen ratio
Calcium ions (1.15 μmol.)	Manganese ions (1.5 μmol.)	Adenosine triphosphate (μmol.)	
–	–	–	1.70
+	–	–	0.12
+	–	0.1	0.07
+	–	0.2	0.07
+	–	0.5	1.03
+	–	1.0	1.02
+	+	–	0.05
+	+	0.1	1.10
+	+	0.2	1.17
+	+	0.5	1.12
+	+	1.0	1.09

hexokinase and magnesium chloride and diluted with isotonic potassium chloride to 25 ml. 2 ml. of this suspension was pipetted into Warburg vessels and incubated for 5 min., before addition of the substrate from the side-arm.

If this pre-incubation is performed in the presence of calcium ions (5×10^{-4} *M*), the system loses its ability to oxidize those substrates requiring the participation of pyridine nucleotides, while it is still capable of oxidizing succinate. This is illustrated in Table 1. The nearly theoretical molar relationship between succinate and oxygen consumed (Fig. 1) substantiates the fact that we are here dealing with the single-step oxidation of succinate to fumarate.

In the above system no esterification of orthophosphate accompanies the one-step oxidation of succinate (Table 2). The effect of added adenosine triphosphate and manganous ions is shown in this table. Adenosine triphosphate alone, when added in sufficiently high concentration (the factors determining this critical concentration of adenosine triphosphate are under further investigation), induces a phosphorylation at a maximum phosphorus to oxygen ratio of about unity. Manganous ions alone, at the concentration tested, had no effect; but the involvement of manganese in the phosphorylative mechanism is indicated by the fact that it potentiates the effects of limiting concentrations of adenosine triphosphate.

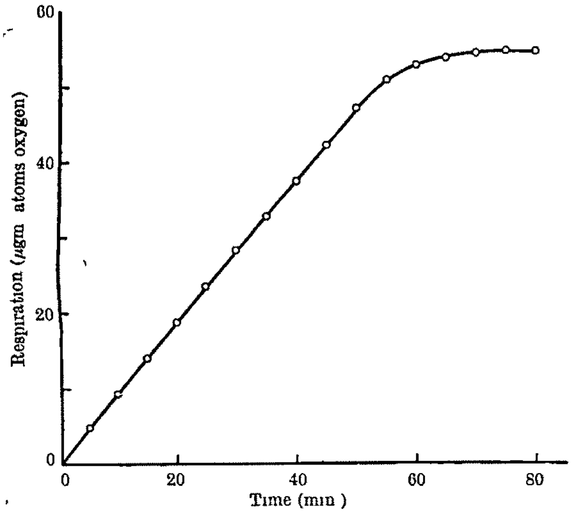


Fig. 1. One-step oxidation of succinate in rat liver mitochondria treated with calcium ions. Added succinate, 50 micromol. Other experimental conditions as in Table 1

LARS ERNSTER
OLOV LINDBERG
HANS LOW

Wenner-Gren's Institute,
Stockholm. Aug. 30.

---

[1] Lindberg, O., and Ernster, L., *Nature*, 173, 1038 (1954).

Inactivation and Activation of Liver Phosphorylase

THE level of phosphorylase in liver slices represents a balance between inactivation and resynthesis of the active form; epinephrine and glucagon rapidly increase the amount of active phosphorylase in preincubated liver slices[1,2]. In order to study the nature of the change in the phosphorylase molecule, liver phosphorylase and the enzyme inactivating it from dog liver have been prepared in purified form. The liver phosphorylase was purified approximately 400-fold, a value higher than previously reported[3]; this purified enzyme was very soluble in water and when inactivated enzymatically showed little or no activity when tested in the presence of adenylic acid. The inactivating enzyme from dog liver was also purified about 400-fold, and this purified enzyme was sufficiently active for microgram quantities to be used in most experiments. Preliminary tests using several proteins as possible substrates have revealed no proteolytic activity.

In searching for possible small fragments released during inactivation, liver phosphorylase inactivated enzymatically was dialysed and the dialysates were analysed. Phosphate was found in the dialysate of liver phosphorylase fractions incubated with the inactivating enzyme, and identical values were found when measurements were made for stable phosphate, or for phosphate as determined by the method of Fiske and SubbaRow[4], or by the Lowry–Lopez method[5]. The phosphate present in the liver phosphorylase was not released when liver phosphorylase was precipitated with cold trichloroacetic acid, so subsequent analyses were conducted by sampling reaction mixtures into trichloroacetic acid and measuring phosphate released enzymatically in the trichloroacetic acid supernatant. Fig. 1 shows the results of such an experiment where the enzymatic inactivation of liver phosphorylase is accompanied by a release of phosphate. 9.5 mgm. of liver phosphorylase in 1.3 ml. of water was incubated with and without 0.038 mgm. of inactivating enzyme (IE), which had been purified approximately 400-fold. At the times indicated along the solid lines, 0.01-ml. aliquots were removed and were assayed for liver phosphorylase activity in a test system which contained adenosine-5-phosphate. At the times indicated along the broken lines, 0.2-ml. aliquots were treated with trichloroacetic acid, and the supernatants after centrifugation were analysed for phosphate. Results are expressed as micrograms of phosphorus released per 9.5 mgm. of liver phosphorylase. The inactivating enzyme alone released no measurable amount of phosphate into trichloroacetic acid supernatants.

Using both the dialysis and trichloroacetic acid precipitation techniques, about 0.25 µgm. phosphorus was found to be released per milligram of liver phosphorylase, or 31 gm. phosphorus per 124,000 gm.

liver phosphorylase Preliminary studies using several other phosphorus-containing compounds, such as *p*-nitrophenyl phosphate, α-glycerophosphate, or sodium pyrophosphate, showed no phosphate to be released by the inactivating enzyme from liver

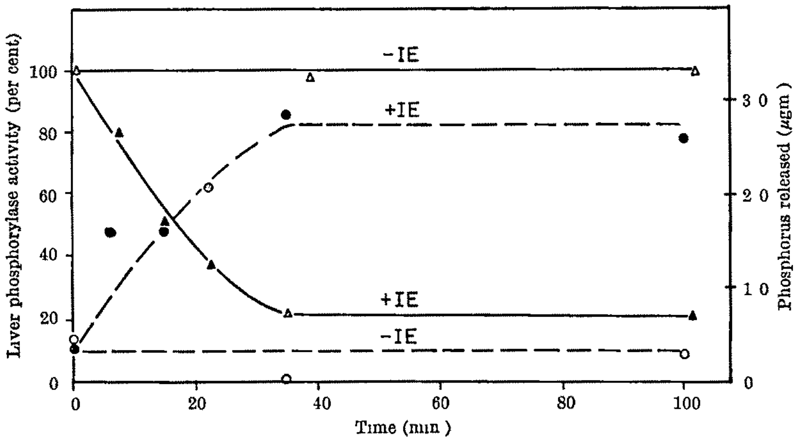


Fig 1

Recent experiments with liver slices have indicated a rapid incorporation of radioactive phosphate into liver phosphorylase Radioactive liver phosphorylase was prepared by incubating liver slices aerobically or anaerobically in the presence of radioactive phosphate and was afterwards purified about 400-fold on a protein basis The incorporated radioactivity was not released when the liver phosphorylase was precipitated with cold trichloroacetic acid, but the radioactivity was released into the trichloroacetic acid supernatant after enzymatic inactivation of liver phosphorylase with the inactivating enzyme In a single preliminary experiment the effect of epinephrine on the incorporation of radioactive phosphate has been investigated The addition of epinephrine to slices after incubation for 30 min increased the amount of active liver phosphorylase within 10 min. to a level well above that of the control without epinephrine, this was paralleled by an increased incorporation of radioactive phosphate into liver phosphorylase

In summary, phosphate is liberated from purified liver phosphorylase as it is inactivated enzymatically, radioactive phosphate is incorporated into the phosphorylase of liver slices These experiments with slices suggest that the observed enzymatic release of phosphate from purified liver phosphorylase is related to a physiological mechanism concerned with the activation and inactivation of liver phosphorylase in intact cells

This work was supported in part by grants from the National Science Foundation and Eli Lilly and Co

Earl W Sutherland, jun
Walter D Wosilait
Department of Pharmacology,
School of Medicine,
Western Reserve University,
Cleveland 6, Ohio Sept 20

---

[1] Sutherland, E W, "Recent Progress in Hormone Research", 5, 441 (Academic Press, New York, 1950)

[2] Sutherland, E W, "Phosphorus Metabolism", 1, 53 (Johns Hopkins Press, Baltimore, 1951)

[3] Sutherland, E W, "Methods in Enzymology", 1 (Academic Press, New York, in the press)

[4] Fiske, C, and SubbaRow, Y, *J Biol Chem*, 66, 375 (1925)

[5] Lowry, O H, and Lopez, J A, *J Biol Chem*, 162, 421 (1946)

A New Amino-Acid from Apples

In an earlier paper[1], two unidentified amino-acids in apples were reported Of these, one (*A*) has now been isolated and shown to have the empirica formula $C_6H_{11}NO_3$ It is tentatively suggested that the substance is 4-hydroxy-methylproline.

The substance was extracted with 75 per cent ethanol from 880 lb of Granny Smith and Delicious apple tree prunings which were dormant, without expanded leaves Purification and separation were carried out with resins ('Zeo-Karb 215' and '225') and a cellulose powder column The unknown was obtained as a hydrochloride, converted to the free base by displacement from 'Zeo-Karb 225' with *N* ammonium hydroxide and was crystallized from a saturated hot aqueous solution to give white micro crystals (Found C, 49 41 H, 7 65, N, 9 85, O, 33 2 Calc for $C_6H_{11}NO_3$ C, 49 64, H, 7 64, N, 9 65, O, 33 07 per cent)

A final yield of 0 08 gm was obtained (quantitative recovery was not attempted) The substance is readily soluble in cold water, insoluble in absolute ethanol and melts with decomposition at about 250° C The unknown gives a yellow colour with ninhydrin and a blue colour with isatin, similar to the colours given by proline The isatin spot does not turn red on being sprayed with Ehrlich's reagent[2] The hydrochloride of the unknown is soluble in water, and in absolute methanol, ethanol and propanol It is insoluble in acetone and ether, which precipitate it from solution as an oil

The analysis, assuming 1 atom of nitrogen, could fit a hydroxy-methylproline or a hydroxy piperidine derivative, but the colour reactions with ninhydrin and isatin and the general chromatographic behaviour (on paper and ion exchange columns) favours the former possibility General evidence consistent with this interpretation is (1) secondary nitrogen was indicated by (*a*) positive test with Feigl's reagent[3], and (*b*) the unknown being recovered unchanged after hydrolysis of the compound formed by reaction with nitrous acid

$$\rangle NH + HNO_2 \rightarrow \rangle N{-}NO \xrightarrow[H_2O]{HCl} \rangle NH.$$

(2) a Kuhn–Roth C—CH_3 test was negative

The suggested structure requires further verification The infra-red spectrum of the unknown is now being examined by other officers of this Division and 4-hydroxy-methylproline is being synthesized by the Department of Organic Chemistry, University of Sydney

I am indebted to officers of the Victorian Department of Agriculture for providing the prunings, and to the following members of the Commonwealth Scientific and Industrial Research Organization Mr P Hunter, Division of Industrial Chemistry, for carrying out the large-scale extraction, Dr W Zimmerman, Division of Industrial Chemistry, for the micro-analysis, Miss M V Haas, for technical assistance, and Dr J. R Price, Division of

Industrial Chemistry, and Dr H S McKee, Plant Physiology Unit, for helpful advice [See also Hulme, A C., *Nature*, December 4, p 1055 (1954)]

G URBACH

Division of Food Preservation and Transport,
Commonwealth Scientific and
Industrial Research Organization,
At the Botany School,
University of Melbourne.
Dec 13

---

[1] McKee, H S, and Urbach, G E, *Aust J Biol Sci*, 6, 369 (1953)

[2] Jepson, J B, and Smith, I, *Nature*, 172, 1100 (1953)

[3] Feigl F, "Qualitative Analysis by Spot Tests", 371 (3rd English edit, Elsevier Pub Co, Inc, New York, 1947)

Infra-red Spectra of the New Proline Derivative from the Apple

IN the work of McKee[1] and of Hulme[2] on apple, two substances have been isolated One of these, from apple peel[2], has been referred to as proline substituted, probably on the same carbon, with methyl and hydroxyl groups The other, from apple twigs, has been referred to by McKee[1] and described above by Urbach as 4-hydroxy-methyl proline, that is, the hydroxyl group is on the methyl side-chain

Samples of the original materials isolated by these authors became available in this laboratory They were therefore subjected to infra-red analysis using the potassium bromide disk method The resulting

evidence

wo sub-

quency 3,400–3,200 cm $^{-1}$) occurs in proline (ref 3, p 208). (3) The band at 3 1 microns (frequency 3,400–3,200 cm $^{-1}$) is characteristic of an imine (ref 3, p 213)

To this point the evidence, though consistent with the substance being a proline substituted with both methyl and hydroxyl groups, does not distinguish between the alternative structures suggested by Hulme and by Urbach While the analysis of these curves, following Bellamy[3], may seem to favour the tentative conclusion of a hydroxyl linked directly to carbon in the ring, it is obvious that a decision awaits other evidence, such as that of synthesis and comparison of infra-red curves for other model compounds

The observations reported above were made possible through the Grasselli Grant to Cornell University for work being directed by one of us (F C S)

A C HULME
F C STEWARD

Department of Botany,
Cornell University,
Ithaca, New York

---

[1] McKee, H S, Comm and Proc 8th Int Cong Botany, Paris, 1954, Sections 11-12, p 101

[2] Hulme, A C, Comm and Proc 8th Int Cong Botany, Paris, 1954, Sections 11-12, p 398, *Nature*, 175, 1055 (1954)

[3] Bellamy, L J, "The Infra-red Spectra of Complex Molecules" (London 1954)

Consideration of the Vi-phage Types of *Salmonella typhi* on a Structural Basis

lished work[1a,b,c] has indicated that
ypes of the typhoid bacillus owe
actions with the adapted prep-
the carriage of temperate

to the various types can be divided into two groups those which are modified in phenotype only and revert to phage A when propagated on Type A, and those which present the characters of genotypic or host-range mutants, this being a permanent change conditioned by the Vi-types on which they have been grown. Members of the latter group retain the power to attack the types on which they have been propagated whatever subsequent phenotypic adaptations they may undergo The broad rule has been established that the non-lysogenic types of *Salm typhi* impose only a phenotypic change on Vi-phage II, whereas the lysogenic types produce a genotypic alteration. There are, however, several exceptions to this rule

The artificial replication of naturally occurring Vi-types can be effected by lysogenizing non-lysogenic types with type-determining phages[1a,b,c] For example, Type F_2, which carries phage f_2, can be made by lysogenizing Type F_1 with phage f_2 These artificially prepared types are indistinguishable from those occurring naturally It has recently been found convenient to consider the lysogenically determined Vi-types in terms of the complex non-lysogenic type plus type-determining phage Thus, using the example given above, Type F_2 would be designated $F_1(f_2)$, where the symbol in parentheses indicates the phage carried Such a nomenclature gives a structural formula which shows the phylogenetic relationships of the Vi-types concerned. The types of *Salm typhi* that will be lysed by an adapted phage can be predicted from the structural formula of the type on which the adaptation has been carried out For example, Type 33 = $C(d_6)$ Phage d_6 is the determining phage carried by Type D_6, which is structurally $A(d_6)$. Vi-phage II adapted to $C(d_6)$ acquires simulta
range of phage C plus that of ph
an adaptation to $C(d_6)$ will b

Table 2

Starting phage	Structural formula of lysogenic type on which the starting phage was grown	Non-lysogenic type on which starting phage is propagated	Predicted type of resulting phage	Structural formula of type to which new phage corresponds
F_2	$F_1(f_2)$	A	29	$A(f_2)$ = Type 29
F_2	$F_1(f_2)$	C	30	$C(f_2)$ = Type 30
29	$A(f_2)$	C	30	$C(f_2)$ = Type 30
30	$C(f_2)$	A	29	$A(f_2)$ = Type 29
D_6	$A(d_6)$	C	33	$C(d_6)$ = Type 33
33	$C(d_6)$	A	D_6	$A(d_6)$ = Type D_6
26	$A(26')$	E_1	31	$E_1(26')$ = Type 31
31	$E_1(26')$	A	26	$A(26')$ = Type 26

Table 1 shows the application of the structural formulæ to the known lysogenically determined types

A lysogenically determined type will not be sensitive to Vi-phage II adapted to another type carrying the same or a similar determining phage, unless its non lysogenic precursor is the same as that of the other type (for example, Type C is the common precursor of Types 30 and 33 in the illustration given earlier) or is the universally sensitive Type A Thus Type F_2, which has the structural formula $F_1(f_2)$, is resistant to phages 29 and 30—both adapted to types carrying phage f_2—because the non-lysogenic precursors of Types 29 and 30 (A and C respectively, see Table 1) cannot modify Vi-phage II so that it will lyse Type F_1 Thus, the difference between Vi-phage II adapted to Types F_2, 29 and 30 is the same as the difference between this phage adapted to Types F_1, A and C respectively, and neither phage A nor phage C will lyse Type F_1.

When Vi-phage II has been gr a lysogenic type that
phenot

host-range mutants that pre-exist in concentrated preparations of phage *A*.

E. S Anderson

Central Enteric Reference Laboratory
and Bureau,
Public Health Laboratory Service
(Medical Research Council),
Colindale,
London, N W 9
Oct 25

[1] (*a*) Anderson, E S , *J Hyg* , *Camb* , 49, 458 (1951) (*b*) Felix, A , and Anderson, E S , *Nature*, 167, 603 (1951) (*c*) Anderson, E S , and Felix, A , *J Gen Microbiol* , 9, 65 (1953)

[2] Craigie, J , and Yen, C H , *Canadian Pub Health J* , 29, 448, 484 (1938)

[3] Anderson, E S , and Felix, A , *Nature*, 170, 492 (1952) , *J Gen Microbiol* , 8, 408 (1953)

Effect of Aeration on the Formation of Nitrate-reducing Enzymes by *Ps. aeruginosa*

Skerman[1], using a recording polarograph, reported that an actively growing culture of *Pseudomonas* was saturated with oxygen only when the broth was agitated by a stirrer revolving at 500 r p m , and that under such conditions nitrate was not reduced In cultures stirred at 100, 200 or 300 r p m , there was a rapid drop in the oxygen tension and nitrate was then reduced.

Experiments carried out in this laboratory, using suspensions of *Ps aeruginosa* N C T C 6750 grown in 0 2 per cent nitrate broth and aerated by continuous shaking, suggested that aerobic denitrification occurred in some of the cultures The inability of most of the shaken cultures to reduce nitrate anaerobically when tested in Warburg manometers suggested that oxygen was inhibiting the formation of nitrate-reducing enzymes, the occasionally active suspension being presumably due to incomplete aeration. The only obvious variables to account for the occasionally active cultures were differences in the size and shape of the flasks used Therefore an experiment was carried out to determine the effect of altering the size and shape of flask on the denitrifying activity of the suspension Six different flasks (Fig 1, 1–6) were used

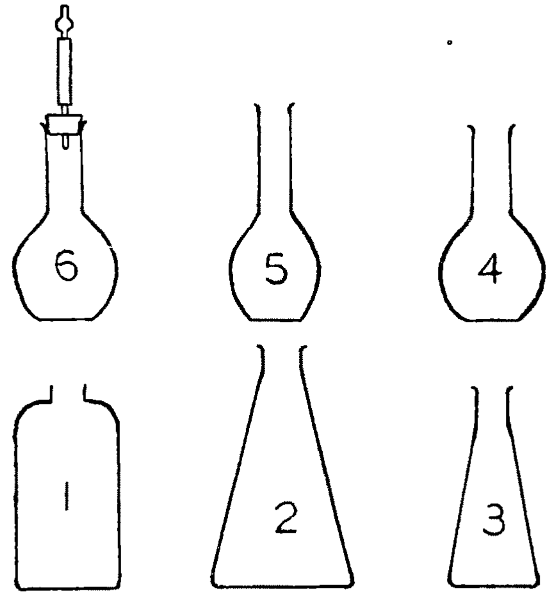


Fig 1 1, One-litre bottle used for intravenous glucose administration 2, One-litre Erlenmeyer flask 3, 500-ml Erlenmeyer flask 4, 500-ml Florence flask 5, 490-ml Florence flask 6, 500-ml Florence flask fitted with a tight-fitting rubber bung, tubing and clip for replacing the air with nitrogen

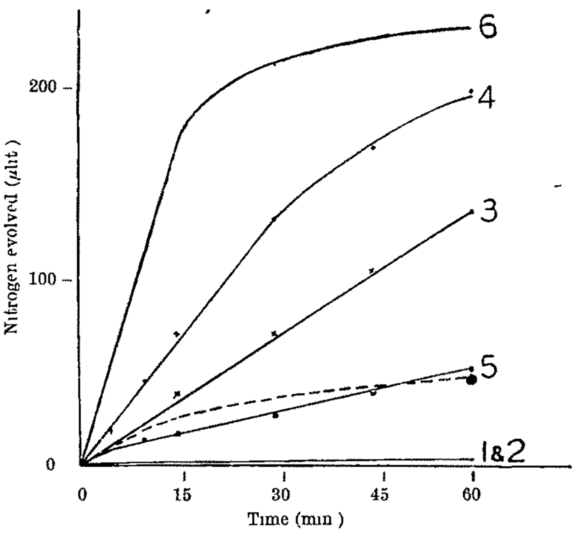


Fig 2 Evolution of gaseous nitrogen by suspensions 1–6 under anaerobic conditions The broken line represents endogenous gas evolved by suspension 6

Each flask, containing 200 ml nitrate broth, was inoculated and shaken at 37° C for 16 hr The growth was washed twice with saline and resuspended in *M*/15 phosphate buffer, *p*H 7 4, and standardized turbidimetrically The suspensions numbered 1–6 were tested for nitrogen evolution in Warburg manometers using 0 1 ml of *M*/5 sodium nitrate as the source of oxygen and yeast autolysate as the hydrogen donor[2] The air was replaced by oxygen-free nitrogen, a small stick of yellow phosphorus being included in each cup to remove all traces of oxygen

Suspension 6 reduced the nitrate quantitatively to nitrogen gas in about 15 min at the rate of 58 µl /hr / mgm. of wet-weight of cells Suspensions 1 and 2 showed no denitrifying activity and the rates for suspensions 3, 4 and 5 were 11, 15 and 4 5 µl nitrogen/ hr /mgm of wet-weight of cells respectively The gas evolution by the last three suspensions showed that aeration of flasks 3, 4 and 5 was insufficient to prevent the formation of nitrate-reducing enzymes, although the suspensions showed a much lower activity than the anaerobic control Aeration of the cultures in flasks 1 and 2 was enough completely to inhibit the formation of the nitrate-reducing enzymes The larger volume of air and the more violent agitation of the broth in flasks 1 and 2 resulted in more efficient aeration of the cultures compared with those in flasks 3, 4 and 5 Hence the efficiency of aeration of the culture determined the ability of the suspension to reduce nitrate to gaseous nitrogen when tested under anaerobic conditions

This work indicates that reports of aerobic denitrification by various workers[3] using shallow layers of undisturbed media and also deeper layers aerated by bubbling air through the medium may well be due to failure to meet the high oxygen demand of a rapidly multiplying aerobic organism in a liquid medium Many methods of forced aeration in deep cultures were insufficient to maintain oxygen saturation, especially as the growth became denser, and it was then that denitrification was detected, apparently under aerobic conditions

In addition to the size and shape of the flask, other factors such as the volume of medium, the organism and the speed and amplitude of shaking may affect the aeration The work is being continued with several other strains of denitrifier and the results will be described in detail elsewhere

F M COLLINS

Department of Bacteriology,
University of Adelaide,
South Australia Sept 1

[1] Skerman, V B D , Lack, J , and Millis, N , *Aust J Sci Res* , B, **4**, 511 (1951)

[2] van Niel, C B , and Allen, M D , *J Bact* , **64**, 397 (1952)

[3] Meiklejohn, J , *Ann App Biol* , **27**, 558 (1940) Sacks, L E , and Barker, H A , *J Bact* , **58**, 11 (1949) Marshall, R O , Dishberger, H J , McVicar, R , and Hallmark, G D , *J Bact* , **66**, 254 (1953)

The Long-finned Tunny, *Germo alalunga* (Bonnaterre), in British Seas

MR S S PICKARD has kindly supplied details and a photograph of a long-finned tunny, albacore or germon, *Germo alalunga* (Bonnaterre), found alive in a shallow pool at low tide at Morecambe, Lancs, on August 14, 1954 The fish measured 32 in from snout to caudal fork, had a pectoral fin 12 in in length and weighed 22 lb This is only the twelfth British record of the species, the other eleven being as follows, the numbers indicating the footnote references 1–11 (1) "Several years" prior to 1846 (Mount's Bay, Cornwall), (2) summer of 1846 (Mount's Bay, Cornwall), (3) March 13, 1861 (Chesil Beach, Weymouth, Dorset), (4) August 26, 1865 (mouth of River Exe, Devonshire), (5) October 25, 1897 (Silloth, Solway Firth), (6) June 1900 (off the Orkney Is), (7) autumn 1901 (coast of Wexford), (8) August 1914 (Dugort, Achill Island, Co Mayo), (9) November 1932 (Lochgoilhead, Firth of Clyde), (10) June 20, 1934 (Kilmun, Holy Loch, Firth of Clyde), (11) September 16, 1947 (west of Dingle, Co Kerry)

Germo alalunga is essentially a warm-water species, ranging widely through the Atlantic from Massachusetts to the West Indies and from the Orkneys to the Cape of Good Hope, and entering the western Mediterranean Off Spain, in the Bay of Biscay and towards the approaches of south-west Ireland, there is a considerable fishery for it, but Moreau[12] gives the Bay of Morlaix as the eastern limit along the Breton coast and states that the germon is extremely rare in the Channel beyond there Saemundsson[13] gives no records for Iceland, nor Smitt[14] nor Andersson[15] for Scandinavia A solitary 'record' for Holland ascribed to van Bemmelen[16] by several authors proves to be unfounded van Bemmelen writes generally of unidentified tunny in the North Sea and mentions two European species, but with no positive identification or presumption of *G alalunga* in Dutch waters

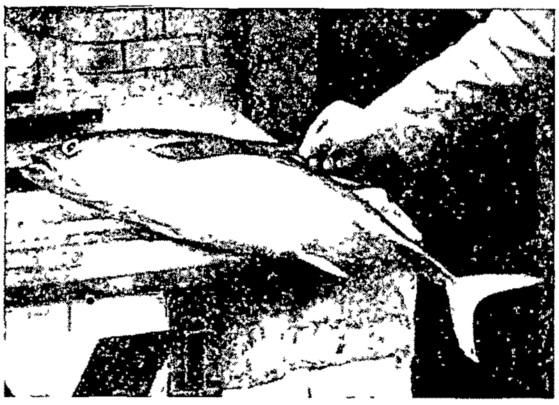


Fig 1 Long-finned tunny, stranded at Morecambe on August 14, 1954

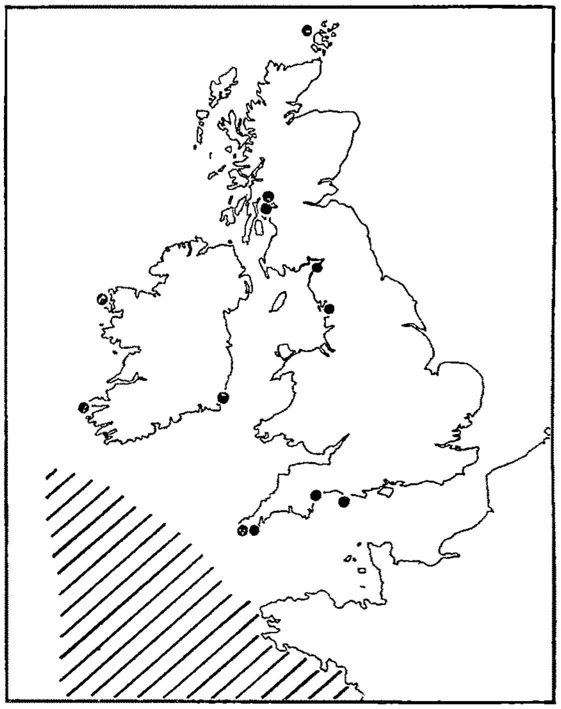


Fig 2 Distribution of *Germo alalunga* in British waters The cross-hatched area shows the approximate northern limits of the French germon fishery

This, then, is a fish which is near the northern limits of its range in British seas, and its occurrence is of interest in relation to modern studies[17] on the effects of climatic fluctuations on the distribution of northern faunas The excellent work on the food of the germon by Legendre[18] and by Bouxin and Legendre[19] will serve equally well as an introduction to its general biology and to relevant literature

DENYS W TUCKER

British Museum (Natural History),
Cromwell Road,
London, S W 7 Oct 20

[1] Couch, R Q , *Zoologist*, **4**, 1413, fig (1846)

[2] Couch, J , "Hist Fish Brit Is ", **2**, pl 84 (London, 1877)

[3] Thompson, W , *Ann Mag Nat Hist* , (3), **7**, 340 (1861)

[4] Scott, W R , *Ann Mag Nat Hist* , (3), **16**, 268 (1865)

[5] Macpherson, H A , *Ann Scot Nat Hist* , 52 (1898)

[6] Harvie-Brown, J A , *et al* , *Ann Scot Nat Hist* , 248 (1900).

[7] Scharff, R F , *Irish Naturalist*, **11**, 105, fig (1902)

[8] Nicholls, A R , *Irish Naturalist*, **23**, 227 (1914)

[9] Stephen, A C , *Scot Naturalist*, 26 (1933)

[10] Stephen, A C , *Scot Naturalist*, 128 (1934)

[11] Went, A E J , *Irish Naturalist's J* , **9**, No 7, 179 (1948)

[12] Moreau, E , "Hist nat Poissons France", **2**, 430 (Paris, 1881)

[13] Saemundsson, B , Marine Pisces, *Zool Iceland*, **4**, Pt 72 (Copenhagen and Reykjavík, 1949)

[14] Smitt, F A , "Hist Scandinavian Fishes" (Stockholm, 1893)

[15] Andersson, K A , "Fiskar och Fiske i Norden" (Stockholm, 1942)

[16] van Bemmelen, A A , Lijst van Visschen 338, in Herklots, J A "Bouwstoffen voor eene Fauna van Nederland", **3** (Leyden, 1866)

[17] Ahlmann, H W , *et al* , *Cons Int Explor Mer Rapp Proc Verb* , **125**, 1 (450 refs) (1949)

[18] Legendre, R , *Ann Inst Océanogr Paris*, **14**, 247 (1934)

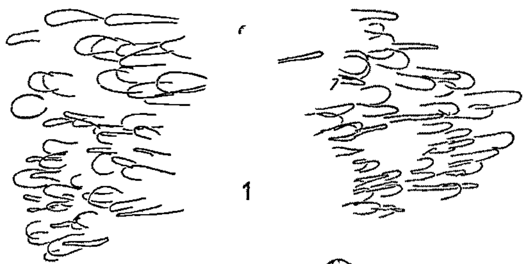
[19] Bouxin, Mme J , and Legendre, R , *Ann Inst Oceanogr Paris*, **16**, 1 (1936)

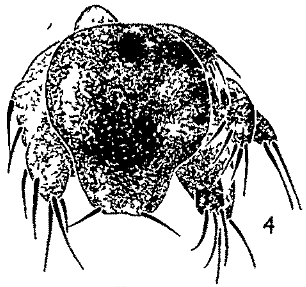
Triploid Nauplii of *Calanus finmarchicus*

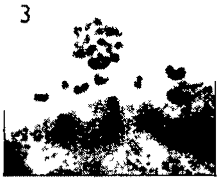
WHILE examining the chromosomes of developing eggs of *Calanus finmarchicus*, it was noticed that on two occasions a proportion of the eggs of a clutch were triploid with 51 chromosomes, the haploid number being 17 It has been observed also that clutches of eggs of *Calanus finmarchicus* are occasionally seen in which one (rarely more) of the eggs is much larger than sister eggs of normal size In order to find out whether these large eggs are triploid, one just about to undergo the fourth cleavage was fixed in acetic alcohol immediately the nuclear membranes disappeared, and a squash was made with aceto-carmine The chromosomes were rather faintly stained, but in one of the divisions, as shown in Fig 1, 102 chromosomes could be counted in anaphase, 51 on each side

Most of the outsize eggs developed with their smaller fellows up to about the gastrula stage quite normally, but as a rule they did not hatch with the rest and died later Up to at least the anaphase of the third cleavage, however, the triploids divided synchronously with their diploid sisters On a very few occasions the large eggs have actually hatched into nauplii correspondingly large in size One of these appeared to be quite normal except for its gigantism, but in an attempt to rear it further this specimen was lost A second specimen which hatched (Fig 4) was a monster with an abnormal first antenna and the second antenna and mandible united on one side A normal nauplius is shown in Fig 5 drawn to the same scale for comparison

There are several ways in which a triploid embryo may arise, but most of them are ruled out here That large size is often associated with a polyploidy is well known, but in this example the large size of the egg at the time it is laid indicates that the polyploidy must have arisen earlier than the time of laying A normal egg is laid when the chromosomes are arranged on the metaphase plate of the first maturation division, 17 bivalents, in the form of rings, being clearly discernible (Fig 2) It is not until several minutes after the egg is laid that the first polar body is produced (Fig 3) If polyploidy were due to the union of a haploid ovum with a diploid sperm, or with two haploid sperms, this event would take place too late to account for the large size, and it seems unlikely that the large size would be responsible for polyspermy One possibility which remains is that the triploid has resulted from the union of a normal, haploid sperm with a diploid egg-cell The most usual way for diploid egg-cells to arise is by failure of reduction at meiosis, but again this would take place too late to affect the size of the egg A diploid egg could arise by reduction from a tetraploid oocyte, the tetraploid condition resulting from the division of the chromosomes of one of the oogonia without a corresponding division of the nucleus This, if it occurred sufficiently early, would account not only for the large size of the eggs, but also for the fact that these do not always occur singly in a clutch of eggs On this hypothesis we might expect to find 1, 2, 4, 8 or some other power of 2 such eggs in a clutch From one of the two clutches of eggs in which triploidy was first observed a sample of nineteen eggs was examined cytologically, of these eleven were diploid, four were triploid and four uncountable From the other abnormal clutch sixteen were examined, two being diploid, two triploid and the rest uncountable Unfortunately, the sizes of these eggs were not noted On the rare occasions when large eggs have been noticed, they have usually occurred singly Once there were four larger than the rest, but three of them were smaller than those usually distinguished as 'large' This hypothesis might also account for the poor viability of the embryos, for with four identical chromosomes of each of the seventeen types, a regular reduction division to 34 bivalents would be a rare occurrence, as tetravalents and trivalents would be formed as well as bivalents However, on all occasions on which accurate counts have been made of the anaphase chromosomes of a dividing triploid cell, precisely 51 chromosomes have been counted on each side







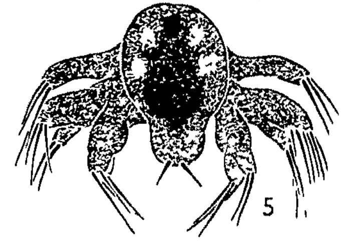


Fig 1 Fourth cleavage of triploid nauplius showing 51 chromosomes on each side at anaphase × 530

Fig 2 Metaphase I from a normal egg immediately after laying, showing 17 bivalents × 670

Fig 3 First polar body formation, 5 min after the egg was laid × 670

Fig 4 Triploid nauplius soon after hatching × 120

Fig 5 Normal nauplius × 120

All figures from preparations preserved in the British Museum (Natural History)

Alternatively, the large egg may be a binucleate one, each nucleus undergoing a normal meiosis in which only bivalents would be formed A triploid embryo would then result from the fusion of the two haploid egg nuclei with one sperm nucleus

It might be possible to distinguish between these hypotheses if a large egg could be examined at the stage corresponding to Fig 2, but these eggs are so rare that we have not yet found one sufficiently soon after it was laid to be able to do this

J P HARDING

British Museum (Natural History),
London, S W 7

S M MARSHALL

Marine Station, Millport Oct 14

Structure of *Vertebraria*

A REMARKABLE completely fusinized specimen of *Vertebraria indica* Royle (Fig. 1) has recently been collected from the south of Jhagrakhand Colliery (Middle Permian) in the Central Province of India. The rock bearing the fossil is a piece of greyish shale. It shows the characteristic rectangular blocks with two longitudinal and a number of transverse grooves of *Vertebraria*. The fusinized rectangular blocks are sometimes as thick as ½ in. This type of well-organized fusinized fossil is not very common.

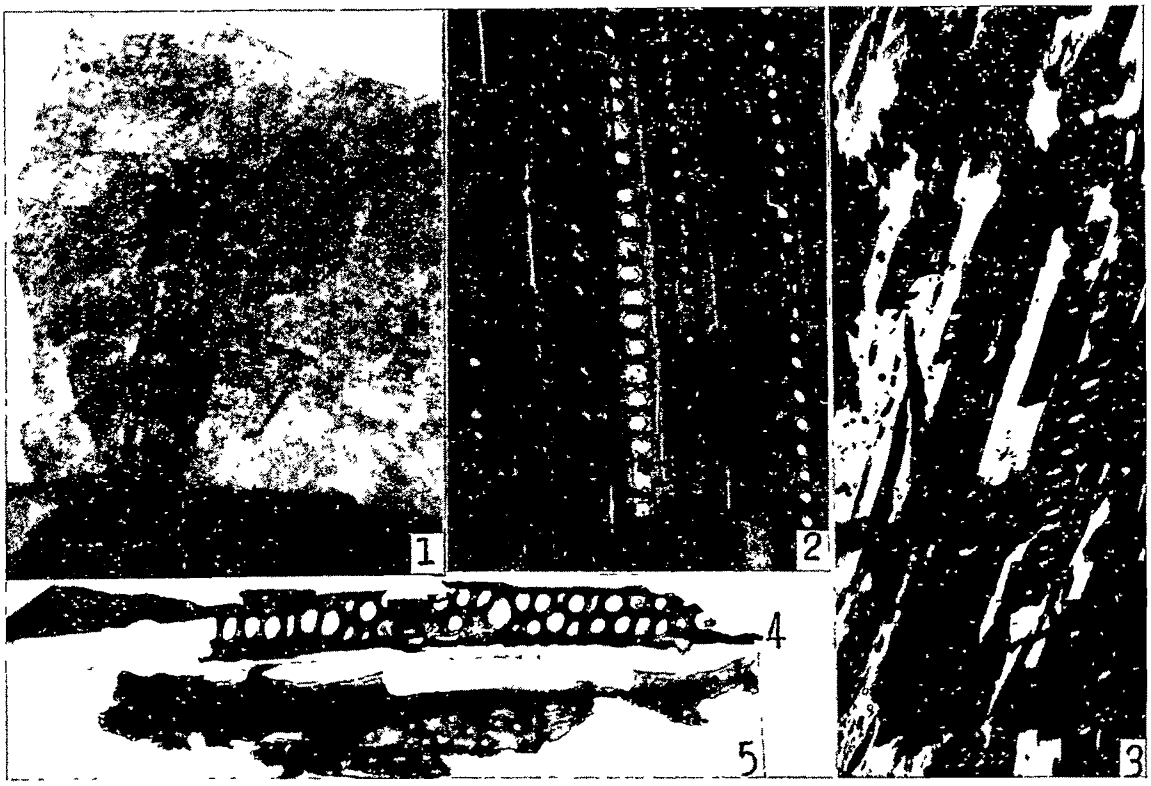


Fig. 1. Part of a shale showing a fusinized axis of *Vertebraria indica*, slightly less than natural size

Fig. 2. Maceration residue from one of the flat fusinized rectangular blocks of the axis shown in Fig. 1, showing tracheids of the secondary wood with uniseriate pitting. × 300

Fig. 3. Part of a cellulose-pull showing a number of tracheids with variously formed pit-closing membranes. × 300

Fig. 4. Maceration residue showing a tracheid with uni- to bi-seriate pitting of different shapes and sizes. × 300

Fig. 5. Maceration residue showing a tracheid with irregular pitting. × 300

All attempts to bring out the nature of the primary wood by getting suitable transverse sections of the fusain failed. Only the secondary wood could be profitably examined by preparing cellulose peel and maceration residues.

Since the structure of the secondary wood of *Vertebraria* has been excellently described by Walton and Wilson[1], only points of additional interest have been noted here. The tracheids vary considerably in breadth (15.5–40 μ), with one to three series of bordered pits on the radial walls. The pits are closely or slightly contiguous, rarely separated, and sometimes a few are abruptly isolated; they may be circular but are more often elliptical, and the size ranges from almost pinhole-like to quite large and well-formed pits (Figs. 2–3). In some tracheids there are regular closing membranes which may partially or wholly close the pit orifices (Fig. 3). The characteristic elliptical or slit-like pit orifices, when present, are due to the membranes closing in from either side of the pits (Fig. 2). The same tracheid may often bear uni- and regularly or irregularly bi-seriate pits of widely different shapes and sizes (Fig. 4). Sometimes the pits are all irregularly arranged (Fig. 5). Such features are often clearly visible and as such cannot be due to poor preservation. It appears that some of these tracheids are exhibiting transition stages between the scalariform and pitting[2]. The general impression is that the irregular organization of some of the tracheids is of primitive nature.

The entire thickly fusinized rectangular blocks yielded closely knit masses of tracheids often in association with small rays one to two cells high. The previous interpretation that "the rectangular areas represent the large medullary rays and the longitudinal and transverse grooves or ridges the secondary wood" only[1], therefore, needs careful re-examination.

It is expected that the examination of other similar specimens (now being sought) from the Sohagpur Coalfield may reveal the general nature of the anatomical organization, especially of the primary wood, in *Vertebraria*. This is obviously important for our knowledge of the *Glossopteris* flora.

I wish to thank Mr. S. K. Ghosh, geologist in the Sohagpur Coalfield, for the material.

J. SEN

Botanical Laboratory,
University College of Science,
Calcutta 19. Oct. 1.

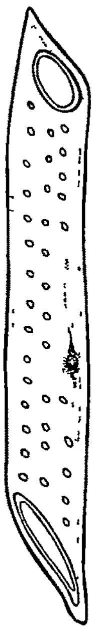
[1] Walton, J., and Wilson, J. A. R., *Proc. Roy. Soc. Edin.*, 52, 202 (1932).

[2] Sen, J., *Bull. Bot. Soc. Bengal*, 2, 97 (1948).

Presence of Nucleus and Cytoplasm in the Mature Vessel Elements and Fibre Tracheids in Japan Jute Plants

It is commonly held that the mature vessel elements of plants are non-living cells. In jute[1], the cell-wall of the vessel elements is lignified and has scalariform thickening and simple pits on the lateral walls Esau has stated "In the mature state, tracheids and vessel members are more or less elongated cells with lignified secondary walls and devoid of protoplasts" In a recent publication[2], she mentions (p 225) "After the secondary walls are fully formed and lignified the swollen parts of the primary wall break down (fig. 11 3,*F* and plate 25,*D*) and finally the protoplasts die and disappear". The course of events is interpreted by Shah[3] in the following way "The disappearance and loss of the protoplast usually synchronizes with the formation of perforation plates (Eames and MacDaniels, fig 49, Esau, figs 11–13)" Recently, I have described[4] how, during the course of development of primary vessel elements, "the protoplasts disappear after the deposition of the secondary thickening matter"

In a recent investigation of the stem of jute plants grown in East Bengal, nucleus and cytoplasm were found in the mature vessel elements and fibre tracheids of the secondary xylem (Figs 1–3) Nucleus and cytoplasm were not observed in the vessels of all the varieties of jute plants but only and rarely in the variety Japan of the species *Corchorus capsularis* The fibre tracheids in the secondary xylem with nucleus and cytoplasm are abundantly present in the varieties Fanduk and Japan of this species The nucleated vessel elements are considerably elongated cells having lignified walls, simple perforations and simple pits in the lateral walls The nucleus with a single nucleolus is prominent and lies embedded in a small amount of cytoplasm The cytoplasm is granular and vacuolated In the fibre tracheids both the nucleus and cytoplasm are very prominent The prominent cytoplasm in some fibre tracheids is found to extend more than half the length of each tracheid (Figs 2 and 3)



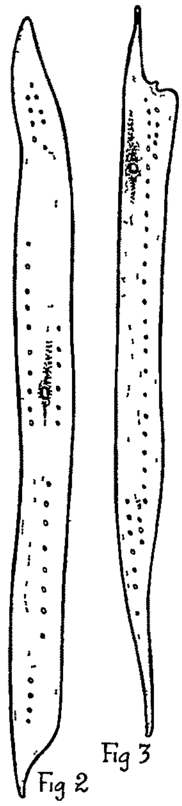


Fig 1 A vessel segment with a single perforation showing nucleus and cytoplasm × 550

Figs 2 and 3 Fibre tracheids of secondary xylem with prominent nucleus and cytoplasm × 550

This condition was first reported by Shah[3], who examined the macerated materials of the tendrils of *Vitis repens* growing in Surat I have also examined the macerated materials of the stems of jute plants

The finding of nucleus and cytoplasm in the mature vessel elements, as well as in the fibre tracheids, is contrary to the observations of Esau and of Eames and MacDaniels

A J Mia

Jute Research Institute,
Tejgaon, Dacca.
Aug 29

[1] Eames and MacDaniels, "An Introduction to Plant Anatomy", 2nd edit (McGraw-Hill, New York, 1947)

[2] Esau, K, "Plant Anatomy", 1st edit (Wiley, New York, 1953)

[3] Shah, J J, *Curr Sci*, 23, No 2 (1954)

[4] Mia, A J, *Pakistan J Sci Research*, 6, No 1 (1954)

Revision of Supposed Jurassic Angiosperms from New Zealand

In Arber[1], Laurent identified two angiosperms, *Artocarpidium arberi* Laurent and *Phyllites* sp, on a slab of matrix from a large collection from Waikato Heads, Arber[1] also identified *Cladophlebis australis* (Morris) in the same slab and suggested a Neocomian age for the whole collection In spite of intensive collecting at Waikato Heads, no further angiosperms have been found, and Edwards[2] doubted whether the slab came from Waikato Heads He concluded that the rest of the Waikato Heads flora is Upper Jurassic. Evidence is presented here in support of Edwards's suggestion that the slab did not come from Waikato Heads, and further that it came from Upper Cretaceous (about Maestrichtian) coal measures of Pakawau, South Island The age of the remaining plant fossils truly from Waikato Heads is not precisely known Dr C A Fleming (New Zealand Geological Survey) has told me that the underlying marine beds are probably Neocomian

The two angiosperms resemble specimens from Pakawau *Artocarpidium arberi* resembles *Fagus producta* Ettingshausen[3], and *Phyllites* sp resembles an undescribed species from Pakawau The fern-like plant on the slab identified as *Cladophlebis australis* by Arber[1] (Pl IV, Fig. 1, Pl XIV) and one cycad cannot be matched in other material from Waikato Heads It is really *Blechnum priscum* Ettingshausen[3], described from Pakawau, and not known from older rocks. In addition, I have identified a cycad on the slab as *Taeniopteris stipulata* Hector[4], a species founded on specimens from Pakawau and unknown from pre-Turonian beds in New Zealand *T. stipulata* was not recorded by Arber.

Moreover, the specimen of Arber's "*Cladophlebis australis*" (Arber[1], Pl. IV, Fig. 1) is also the original of a figure on an unpublished plate, prepared by Hector, in a series labelled "Pakawau" in his handwriting

The cause of the error may lie in the numbering of the specimens, specimens from Pakawau are registered with the New Zealand Geological Survey locality number 409 (collected by the Geological Survey in 1866), and those from Waikato Heads bear the number 410 (collected by the Geological Survey in 1868). Apparently, a slab from the Pakawau collection was wrongly numbered and placed in the Waikato Heads collection

The earliest New Zealand angiosperms known at present are those from beds in the Middle Clarence Valley, which on the evidence of plant microfossils are Turonian in age

D R McQueen

New Zealand Geological Survey,
156 The Terrace,
Wellington, New Zealand.
Sept. 22

---

[1] Arber, E A N, *N Z Geol Surv Pal Bull*, 6, 62 (1917)

[2] Edwards, W N, *Ann Mag Nat Hist*, (10), 13, 86, 87 (1934)

[3] Ettingshausen, C v, *Trans N Z Inst*, 23, 237 *et seq* (1891)

[4] Hector, J, Det Cat Ind Col Exhib (London), Fig 24A, 3, N Z Geol Survey, Wellington (1886)

A Seed-borne Nematode Infestation in Annual Asters

Aphelenchoides ritzema-bosi has a wide host-range but is most frequently recorded as a pest of chrysanthemums In this plant, infestations usually start at the base of the stem and work upwards in the direction of the flower head. In severe attacks, most of the leaf area is killed, and the flower head itself may become infested Chrysanthemums are normally propagated vegetatively, and hence seed-borne infestation is unlikely to occur. However, some hosts of *A ritzema-bosi* are grown from seed, and the object of this communication is to record seed-borne infestation in the annual aster (*Callistephus chinensis*).

In early May 1954, severe injury was noted on aster plants being grown in sterilized compost in seed boxes on a nursery in Suffolk. These plants were found to be heavily infested with *A. ritzema-bosi*, living mainly ectoparasitically in the leaf axils Fortunately a supply of the original seed was available for examination. 14 gm. of seed was placed in a Baermann funnel and more than three hundred nematodes were extracted Small pieces of leaf and sepal debris were present mixed with the seed, and nematodes emerged in large numbers from this debris and also from seed from which the debris had been removed It therefore seems probable that the species was living both ecto- and endo-parasitically in the flower head, and that a proportion of the nematodes was attached to or in close association with the seed coat. Identical symptoms were reproduced in the laboratory on aster plants raised from this seed in sterilized compost

Seed-borne infestation in the genus *Aphelenchoides* has not hitherto been recorded A full account of this occurrence and of the symptoms on the aster plants will be published elsewhere.

E. B Brown

National Agricultural Advisory Service,
Anstey Hall,
Trumpington, Cambridge.
Oct 7

The Genetic Component of Language

R W. Thompson, in discussing the genetic component of language[1], complains that Darlington and Mather, in an introduction to genetics[2], "have simplified the issue" This is true, and one of the complications Mr Thompson introduces is highly appropriate But in my original paper I had considered it[3].

In this paper I tried to explain certain principles

(1) That the three threads by which continuity and change may be followed in language, namely, grammar, etymology and phonetics, are in a long-term sense independent.

(2) That only on the phonetic side do we expect or find a serious genetic component

(3) That the genetic preference of the group rath than the genetic capacity of the individual is wh determines phonetic evolution

Among the instances I gave of the working of these principles was the one quoted by Mr. Thompson, namely, the intrusion of the dental fricative along different lines, at different times and in different parts of the Spanish-speaking world, an instance which might be elaborated from the study of Latin American dialects.

Mr Thompson suggests that the theory of a genetic component of language was regarded as speculative by Darlington and Mather It is speculative in the sense that it is a beginning rather than an end of investigation It opens new ground for research in phonetics, linguistics, anatomy and psychology, and ultimately in the general understanding of human society. What we have to do is to apply non-genetic ideas and techniques in relation to the genetics of individuals and of populations

I may give an example of each.

(1) Mr Thompson agrees that "the speech organs of various races vary in shape". But he maintains that these variations could have no influence on the production of speech except on timbre Are we to suppose, then, that the defects of speech which may distinguish one child from his brothers and sisters never have any basis in the shapes of nerves, muscles or bones ? Or conversely, that the established genetic control of differences in tongue control has no effect on the ease of pronouncing various sounds ? I do not believe either of these corollaries of Mr. Thompson's view. But the anatomist and the speech therapist could test their truth, and their observations would help to solve our problem

(2) We have to discover just how the community, its classes and individuals, interact over long spaces of time in small and large, stable and changing, literate and illiterate societies We now understand enough of the genetics of these situations to relate them with the historical evidence[4].

Such is the speculation. But the principle of genetic determination in language itself is far from speculative Those who now object will be telling us soon enough that it is little more than a truism.

C. D Darlington

Botany Department,
Oxford
Dec 16.

---

[1] Thompson, R W, *Nature*, 174, 1095 (1954)

[2] Darlington, C D, and Mather, K, "The Elements of Genetics" (Allen and Unwin, London, 1949)

[3] Darlington, C D *Heredity*, 1, 269 (1947).

[4] Darlington, C D, "The Facts of Life" (Allen and Unwin, London, 1953)

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 24

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street London, W C 1), at 5 30 p m —Dr J T Davis and Prof H Dingle "The Age of the Universe"

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W C 2), at 5 30 p m —Captain F J Wylie, R N (Retd) "Radio Aids to Marine Navigation"

UNIVERSITY OF LONDON (at King's College, Strand, London, W C 2), at 5 30 p m —Prof William Prager (Brown University, U S A) "Approximate Solution of Boundary Value Problems in Mathematical Physics by the Method of the Hypercircle in Function-space" (Further Lectures on January 27 and 28)*

Tuesday, January 25

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W C 1), at 1 15 p m —Prof P B Medawar, F R S "The Errors of Nature" *

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S W 1), at 5 30 p m —Mr J J O'Kelly "The Employment of Unit Hydrographs to Determine the Flows of Irish Arterial Drainage Channels"

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W C 1), at 5 30 p m —Prof J Z Young, F R S "The Language of Neurology, its Advantages and Limitations" *

Wednesday, January 26

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S W 7), at 5 p m —Prof C -G Rossby (Stockholm) "Chemical Composition of Precipitation as a Function of Atmospheric Circulation Patterns" *

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 6 30 p m —Mr D J Fewings and Mr S L Fife "A Survey of Tuner Designs for Multi-channel Television Reception"

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP—NUTRITION PANEL (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Mr E Mitchell Learmonth "Soya in the Field of Nutrition"

Thursday, January 27

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College, Imperial Institute Road, London, S W 7), at 2 30 p m —Scientific Papers

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Mr J C Eisenstein and Prof M H L Pryce, F R S "The Electronic Structure and Magnetic Properties of Uranyl-like Ions", Mr J Sawkill "An Electron Microscope and Diffraction Investigation of Nucleation in Silver Azide"

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Prof R Rado "Some Recent Work on Ordered Sets"

MINERALOGICAL SOCIETY (in the apartments of the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Scientific Papers

INSTITUTE OF FUEL (joint meeting with the COKE OVEN MANAGERS' ASSOCIATION, at the Institution of Civil Engineers, Great George Street, London, S W 1), at 5 30 p m —Paper on the "Dutch State Mines" *

ROYAL METEOROLOGICAL SOCIETY (in the Conference Hall, County Hall, Westminster Bridge, London, S E 1), at 5 30 p m —Mr F H Ludlam "Clouds" (Meeting open to Sixth-form scholars)*

INSTITUTION OF ELECTRICAL ENGINEERS (at the Central Hall, Westminster, London, S W 1), at 6 p m —Mr T B D Terroni "Courier to Carrier in Communications" (Faraday Lecture)

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W 1), at 7 p m —Mr D F Lawden "Dynamic Problems of Interplanetary Flight"

Friday, January 28

BRITISH SOCIETY OF RHEOLOGY (in the Department of Physics, Queen Mary College, Mile End Road, London, E 1), at 2 15 p m —Symposium on "Relaxation and Flow in Glasses"

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP—NORTHERN BRANCH (joint meeting with the LEEDS UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Leeds), at 5 30 p m —Prof M Polanyi, F R S "Objectivity from Copernicus to Einstein"

ROYAL MICROSCOPICAL SOCIETY (in conjunction with the INSTITUTE OF BIOLOGY, in the Chemistry Lecture Theatre King's College, Newcastle-upon-Tyne), at 6 p m —Dr Geoffrey Bourne "The Living Cell"

SOCIETY FOR ANALYTICAL CHEMISTRY (at the School of Pharmacy, Bloomsbury Square, London, W C 1), at 7 p m —Annual General Meeting of the Microchemistry Group 7 30 p m —Scientific Papers

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 9 p m —Prof H Munro Fox, F R S "The Colours of Animals"

Saturday, January 29

INSTITUTION OF CHEMICAL ENGINEERS, NORTH WESTERN BRANCH (at the Engineers' Club, Manchester), at 2 30 p m —Annual General Meeting 3 p m —Sir Christopher Hinton "Some Aspects of the Chemical Processes Ancillary to Atomic Energy"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

ASSISTANT (Grade B), to organize and teach geology and geography to the standard of General B Sc (London)—The Clerk to the Governors, Luton and South Bedfordshire College of Further Education, 63-69 Guildford Street, Luton (January 29)

ASSISTANT LIBRARIAN (with at least A L A)—The Librarian, Chemical Society, Burlington House, Piccadilly, London, W 1 (January 29)

DEMONSTRATOR IN PHYSIOLOGY—The Secretary, London Hospital Medical College, Turner Street, London, E 1 (January 29)

ASSISTANT LECTURER IN THE DEPARTMENT OF CHEMISTRY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (January 31)

LECTURER (preferably with special qualifications in inorganic and analytical chemistry) IN CHEMISTRY, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (South Africa, January 31)

LECTURER (with a good honours degree and some relevant experience, preferably including some research experience in the field of structures or soil mechanics) IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Bristol 8 (January 31)

SENIOR EXPERIMENTAL OFFICER (with a degree or equivalent qualification and laboratory administrative experience) IN THE BIOCHEMISTRY DEPARTMENT—The Secretary, Institute of Animal Physiology, Babraham, Cambs (January 31)

HENRY AND CHARLOTTE PAYNE RESEARCH FELLOW IN CYTOLOGY and/or CYTO-CHEMISTRY, with special reference to malignant cells—The Assistant Secretary, The Royal Society, Burlington House, Piccadilly, London, W 1 (February 1)

LECTURER or SENIOR LECTURER IN BIOLOGY—The Principal, The Training College, Ripon, Yorks (February 1)

SCIENTIFIC TECHNICAL OFFICER (preferably with H N C or similar qualifications in physics or chemistry), to assist in the preparation of intelligence reports, and to be responsible for internal scientific records, including preparation of monthly review of technical press —The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London S W 1, quoting TT/908 (February 2)

ANALYTICAL CHEMIST (with a degree in chemistry or at least H N C in chemistry) to work mainly on the analysis of plant material—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (February 5)

DIRECTOR (with wide research and administrative experience, and ability to co-ordinate research in the various divisions of the Institute, particularly applied research) OF THE CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE, Council of Scientific and Industrial Research (India), Karaikudi, South India—High Commission of India, Establishment Department, Aldwych, London, W C 2, quoting 4/85K (February 8)

LECTURER IN APPLIED PHARMACOLOGY AND THERAPEUTICS—The Dean St Thomas's Hospital Medical School, London, S E 1 (February 8)

PROFESSOR OF PHYSICS—The Registrar, The University, University Office, 46 North Bailey, Durham (February 12)

PHYSICIST (with a good honours degree in physics or similar professional qualifications, proved research ability and preferably some experience of stress analysis) in the Central Research Establishment, National Coal Board, Isleworth, Middlesex, to lead a group carrying out research on coal ploughing—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/906 (February 16)

UNIVERSITY DEMONSTRATOR IN PHYSICS—Dr F B Kipping, Chemical Laboratory, Pembroke Street, Cambridge (February 19)

ASSISTANT LECTURER OR DEMONSTRATOR IN PATHOLOGY—The Registrar, The University, Manchester 13 (February 26)

LECTURER/SENIOR LECTURER (preferably with interests and experience in clinical psychology) IN PSYCHOLOGY, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, February 26)

SENIOR LECTURER IN EDUCATION at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (February 26)

SENIOR LECTURER (with special qualifications in chemical pathology) IN CHEMICAL PATHOLOGY—The Registrar, The University, Manchester (February 26)

CHAIR OF MATHEMATICS, CHAIR OF PHILOSOPHY AND PSYCHOLOGY, and a LECTURER IN MATHEMATICS, at Canberra University College, Canberra, A C T , Australia—The Secretary Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Canberra, February 28)

CHAIR OF PHYSICS—The Registrar, The University, Hull (February 28)

CHAIR OF ANATOMY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, March 1)

I C I RESEARCH FELLOWS IN PHYSICS, CHEMISTRY, ENGINEERING, METALLURGY and PHARMACOLOGY, or any related subject, and LEVERHULME POSTGRADUATE FELLOWS (2) IN THE FACULTY OF SCIENCE—The Registrar, The University, Liverpool (March 1)

HEAD OF THE DEPARTMENT OF ENTOMOLOGY—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (March 31)

I C I RESEARCH FELLOWS IN BACTERIOLOGY, BIOCHEMISTRY, BIOMOLECULAR STRUCTURE, BOTANY (Plant Biochemistry and Biophysics), CHEMICAL ENGINEERING, CHEMISTRY, CHEMISTRY OF LEATHER MANUFACTURE, CHEMOTHERAPY, COLOUR CHEMISTRY and DYEING, ENGINEERING (Civil, Electrical or Mechanical), FUEL AND REFRACTORIES, GEOLOGY (including Geochemistry), METALLURGY, MINING (Selective Flotation and Geophysical Surveying), PHARMACOLOGY, PHYSICS, PHYSIOLOGY or TEXTILE INDUSTRIES (Protein Chemistry and Wool Textile Engineering)—The Registrar, The University, Leeds 2 (April 15)

LECTURER (with an honours degree in botany or agricultural botany, and preferably with postgraduate experience in plant physiology, ecology, genetics or virus pathology) IN THE DEPARTMENT OF AGRICULTURAL BOTANY—The Registrar, The University, Reading (April 15)

I C I RESEARCH FELLOWS IN PHYSICS, CHEMISTRY, BIOCHEMISTRY, ENGINEERING, METALLURGY, PHARMACOLOGY, CHEMOTHERAPY or related subjects—The Secretary General of the Faculties, The Old Schools, Cambridge (April 30)

AGRONOMIST, Scientific Officer or Senior Scientific Officer grade (with at least a second-class honours degree, and not less than two years appropriate postgraduate experience, preferably including acquaintance with tropical tree crops and up-to-date knowledge of the statistical analysis of field experimental results), at the West African Cocoa Research Institute, to assist in laying down field experiments on various methods of cultivating cocoa—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 197/200/05

CHEMIST, Senior Scientific Assistant (with a good honours degree or equivalent qualification, experience in industry, and ability to prepare correspondence and reports), at the Central Laboratory, Chiswick, to be responsible for a section concerned with a wide variety of analytical and investigational work—The Staff Officer (F/EV 507), London Transport, 55 Broadway, London, S W 1

EXPERIMENTAL OFFICERS (preferably with a pass degree), and ASSISTANT EXPERIMENTAL OFFICERS (with at least H S C (science) or equivalent), to assist in the preparation of experimental equipment and in the carrying out of nuclear physics experiments—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 349/WGE/34

EXPERIMENTAL OFFICER (with a degree or equivalent qualifications) IN THE NUTRITION DEPARTMENT, to assist in biochemical research involving chromatography and electrophoresis—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 55/2

FORESTAL LAND, TIMBER AND RAILWAYS CO, LTD, RESEARCH FELLOW (with at least a good honours degree in chemistry, and preferably some research experience, and particular interest in applying fundamental physical chemistry and physical methods of organic chemistry to problems of industrial importance), at the Central Research Laboratory of the Department of Scientific and Industrial Research, Teddington, for research which will be directed to investigating the function of tannins in preventing corrosion of metals—Chief Research Chemist, Forestal Central Laboratory, Harpenden, Herts

HEAD OF THE DEPARTMENT OF CHEMISTRY AND BIOLOGY, and HEAD OF THE DEPARTMENT OF ENGINEERING, at the College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff

LECTURERS (2) (with an engineering or science degree, lecturing experience, and a specialist knowledge of either electrical engineering or electronics, or survey mechanism) at the R E M E Training Centre, Arborfield—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting D 679/54A

MASTER to teach MATHEMATICS up to University Scholarship standard—The Headmaster, Highgate School, London, N 6

MATHEMATICIANS and THEORETICAL PHYSICISTS, to investigate a range of problems in classical and nuclear physics—The Deputy Director, Atomic Weapons Research Establishment, Aldermaston, Berkshire

NUCLEAR PHYSICISTS, Senior Scientific Officer or Scientific Officer grade (with a first- or second-class honours degree in physics or equivalent qualification, and in the case of the S S O posts some years postgraduate research experience in nuclear physics), to work with a 6 MeV Van de Graaff generator and other accelerators—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 348/WGE/34

PRINCIPAL (with experience of teaching, administrative ability and a knowledge of agricultural practice) OF THE INSTITUTE OF AGRICULTURE AND HORTICULTURE, "Oaklands", St Albans—County Education Officer, County Hall, Hertford

SENIOR RESEARCH ASSISTANT (with a good honours degree in engineering, practical experience and/or research training) IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Registrar, The University, Nottingham

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Psychology as the Study of Behaviour an Inaugural Lecture By Prof O L Zangwill Pp 36 (London Cambridge University Press, 1954) 2*s* 6*d* net [1911

The Fruit, The Seed and The Soil Prepared by the Staff of the John Innes Institution (Collected edition of the John Innes Leaflets Numbers 1 to 9) Third edition Pp viii+94 (6 plates) (Edinburgh and London Oliver and Boyd, Ltd, 1954) 5*s* net [1911

Group Discussion in Educational, Social and Working Life Edited by John Burton Pp 92 (London Central Council for Health Education, 1954) 3*s* 6*d* [1911

Imperial College of Science and Technology (University of London) Research Report of the Royal School of Mines, 1950–53 Pp iv+33 (London Imperial College of Science and Technology, 1954) [1911

Department of Scientific and Industrial Research National Physical Laboratory Notes on Applied Science No 8 Audio Frequency Power Measurements Pp iv+16 (London H M Stationery Office, 1954) 1*s* net [1911

Aluminium Development Association Information Bulletin No 8 The Riveting of Aluminium Pp 62 (London Aluminium Development Association, 1954) 2*s* [1911

Institution of Gas Engineers Publication No 455 Chemical Research at the Direction des Études et Recherches du Gaz de France By P C Agron Pp 28 Publication No 456 The West Midlands Approach to the Gasification of Residual Oil By G le B Diamond Pp 40 Publication No 457 The Production of Town Gas by the Catalytic Gasification of Petroleum Oils 2 The Development and Operation of a Commercial Plant By H Stainer and J B McKean Pp 30 Publication No 459 Official Programme—20th Autumn Research Meeting, London, 22nd and 23rd November, 1954 Research Communication GC14 Investigations with a Small Pressure Gasifier Part 1 The Study of the Reactions Occurring in the Fuel Bed By Dr D Hebden, R F Edge and K W Foley Pp 32 Research Communication GC17 An Investigation into the Composition of Ammoniacal Liquor 1 Continuous Vertical Retort Liquor By Dr W H Blackburn Dr L Barker and J R Catchpole Pp 48 Research Communication GC18 a Review of Current Research Work on the Treatment and Disposal of Liquor Effluents from Gas Works By Dr A L Roberts and Dr W B Blackburn Pp 14 Research Communication GC19 Coal Travel in Continuous Vertical Retorts By C H Lewis Pp 25 (London Institution of Gas Engineers, 1954) [1911

Proceedings of the Croydon Natural History and Scientific Society Vol 12—February, 1951 to December, 1952 Pp 81–154 + plates 7–18 10*s* The Excavation of a Fourth Cave at Waddon By A B L Reid Pp 7 2*s* The Denehole Controversy By John E L Caiger Pp 12+2 plates 2*s* The Re-Birth of Croydon in 1851 By D W Blackmore Pp 22+10 plates 3*s* The Coombes and Embayments of the Chalk Escarpment By C C Fagg Pp 15 2*s* (Croydon Croydon Natural History and Scientific Society, 1954) [1 11

Other Countries

Proceedings of the Royal Society of Arts and Sciences of Mauritius Vol 1, Part 3 A Forgotten Work by John Vaughan Thompson By R E Vaughan Pp 241–248+plate 8 (Port Louis Royal Society of Arts and Sciences of Mauritius, 1953) [1911

British Caribbean Meteorological Service Second Annual Report, 1953 Pp 15 (Trinidad British Caribbean Meteorological Service, 1954) 24 cents [1911

Union of South Africa Department of Mines—Geological Survey The Geology of the Koedoesrand Area, Northern Transvaal an Explanation of Sheets 35 and 36 (Koedoesrand) By H N Visser Pp iii+110+14 plates (Pretoria Government Printer, 1953) 10*s* (including map) [1911

Union of South Africa Department of Mines and Department of Economic Affairs Coal Survey Memoir 2 The Northern Natal Coal-Field (Area No 2) The Utrecht-Newcastle Area Part 1 Geological By J J G Blignaut and F J J Furter Part 2 Chemical and Physical By W H D Savage Pp iv+228 (Pretoria Government Printer, 1952) 30*s* (including maps) [1911

New Zealand Department of Scientific and Industrial Research Geophysics Division—Seismological Observatory Seismological Report for July, August, September, 1951 (Bulletin E 125) Pp ii+18 (Wellington Government Printer, 1954) [1911

Smithsonian Miscellaneous Collections Vol 123, No 3 A Method for the Measurement of Atmospheric Ozone Using the Absorption of Ozone in the Visible Spectrum By Oliver R Wulf and James E Zimmerman (Publication 4177) Pp ii+14 Vol 123, No 5 Concerning Smithsonian Pyrheliometry By C G Abbot, L B Aldrich and A G Froiland (Publication 4179) Pp ii+4 (Washington, D C Smithsonian Institution, 1954) [1911

Bulletin of the Scripps Institution of Oceanography of the University of California, La Jolla Vol 6, No 7 Bathypelagic Nemerteans of the Pacific Ocean By Wesley R Coe Pp iii+225–286+plates 8 and 9 (Berkeley and Los Angeles University of California Press, 1954) 75 cents [1911

University of California Publications in Zoology Vol 52, No 5 Comparative Morphology of the Body Skeleton in Recent Canidae By Milton Hilderbrand Pp iii+399–470+plates 12–25 1 dollar Vol 54, No 1 Ecology and Systematics of Salamanders of the Genus Batrachoseps By John R Hendrickson Pp iii+46 75 cents (Berkeley and Los Angeles University of California Press, 1954) [1911

United States Department of Commerce Weather Bureau Research Paper No 37 Pressure Jump Lines in Midwestern United States January–August 1951 By Morris Tepper and other Staff Members of Severe Local Storms Research Unit Pp v+70 (Washington, D C Government Printing Office, 1954) 45 cents [1911

United States Department of Agriculture Leaflet No 372 The Onion Thrips How to Control It Pp 4 (Washington, D C Government Printing Office, 1954) 5 cents [1911

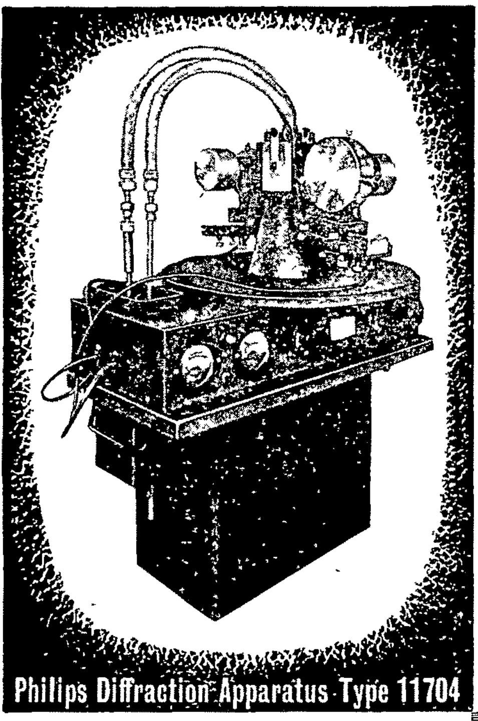
East African Meteorological Department Technical Memorandum No 6 Artificial Inducement or Precipitation in the Tropics By D A Davies Pp 11 (Nairobi East African High Commission, 1954) Sh 1/50 [1911

Tea Research Institute of East Africa Annual Report for the year 1953 Pp 43 (Kericho Tea Research Institute of East Africa, 1954) [1911

Fisheries Research Board of Canada Progress Reports of the Atlantic Coast Stations No 59 Pp 31 (St Andrews, N B Fisheries Research Board of Canada, 1954) [1911

Cawthron Institute Annual Report, 1953–54 Pp 42+3 plates (Nelson, N Z Cawthron Institute, 1954) [1911

Role of Science in the Development of New Zealand Agriculture By Sir Theodore Rigg (Presidential Address to the Australian and New Zealand Association for the Advancement of Science, Canberra, January 13th 1954) Pp 35 (Canberra Australian and New Zealand Association for the Advancement of Science, 1954) [1911



Philips Diffraction Apparatus Type 11704

Send for fully descriptive literature

PHILIPS

X-ray Diffraction Unit

. . . high efficiency at low cost

This 'always ready to switch on' X-ray Diffraction Unit, Type 11704, has many uses and many users. Employing PHILIPS 'sealed-off' tubes with mica-beryllium windows, up to four cameras can be used simultaneously. Simplicity of operation and small dimensions are outstanding features. The price is modest in the extreme.

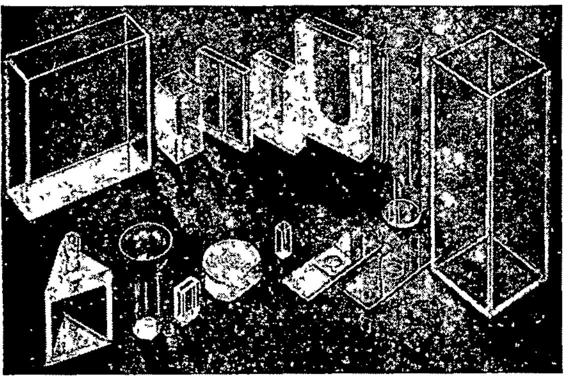
(A product of N. V. Philips, Eindhoven, Holland)

- CHEMICAL IDENTIFICATION
- PHASE ANALYSIS
- SOLID SOLUBILITY STUDY
- SINGLE CRYSTAL STUDIES
- PARTICLE SIZE MEASUREMENTS
- METALLOGRAPHIC STUDIES
- MOLECULAR WEIGHT DETERMINATION
- STRUCTURE IDENTIFICATION
- STRESS ANALYSIS
- FIBRE STUDIES
- PROCESS CONTROL
- ORIENTATION STUDIES

PHILIPS

PHILIPS ELECTRICAL LTD.
X-RAY DIVISION
CENTURY HOUSE SHAFTESBURY AVENUE LONDON W.C.2
(PX10049)

ACID-PROOF VESSELS

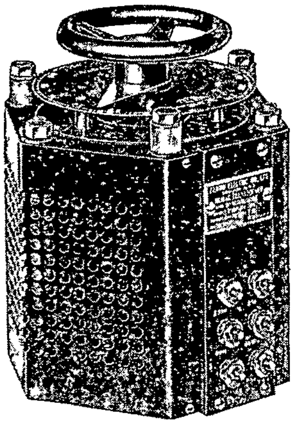


Makers of acid-proof vessels of all types.
Speciality: Cells for experimental purposes involving optical work of any accuracy.

write for illustrated list

C. J. Whilems Ltd.
Ilford Optical Works, FOREST ROAD, BARKINGSIDE, ESSEX

***ZENITH *VARIACS with *DURATRAK**
* REGD. TRADE-MARKS



All VARIAC-DURATRAK Variable Voltage Transformers have a brush track treated in accordance with British Patent No. 693406, which produces a coating of precious metal alloy on the brush track surface, eliminating the possibility of deterioration due to oxidization, and reducing contact resistance.

VARIACS with DURATRAK have longer life, increased overload capacity and maximum economy in maintenance.

Prompt deliveries on all models

Illustrated brochure free on request

The ZENITH ELECTRIC CO. Ltd.
ZENITH WORKS, VILLIERS RD., WILLESDEN GREEN
LONDON, N.W.2
Phone: WILlesden 4087-8-9 *Grams*: Voltaohm, Norphone, London

LECTURES AND COURSES

UNIVERSITY OF BRISTOL

DIPLOMA IN HORTICULTURAL SCIENCE
DIPLOMA IN PLANT PATHOLOGY AND PROTECTION

Courses for the above postgraduate qualifications will commence on September 16 1955 They extend over a full university session of three terms ending in the following June or July Conducted in part at the Long Ashton Research Station, they are intended primarily for those with good honours degrees in science who seek careers in horticultural research, at home or abroad

Early application should be made to the undersigned, from whom full particulars may be obtained

H C BUTTERFIELD,
Registrar and Secretary

UNIVERSITY OF LONDON

DEPARTMENT OF EXTRA-MURAL STUDIES

University Extension Residential Courses in (1) Trends in Physics Research and Teaching, (2) Meteorology Both courses take place April 14 to 20, 1955 Two separate residential courses of one week's duration at Imperial College of Science and Technology, London, for graduates and those with similar experience Lecturers The Professors and Lecturers of the Departments of Physics and Meteorology at the Imperial College of Science and Technology

Further information and application forms may be obtained from the Deputy Director (Ex Nat), Department of Extra-Mural Studies, University of London, Senate House, W C 1

UNIVERSITY OF LONDON

A lecture on "Recent Changes in Spanish Economy" will be given by Professor L P Pardo (School of Advanced Commercial Studies, Barcelona) at 5 30 p m on January 31 at University of London Senate House W C 1

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

UNIVERSITY COLLEGE LONDON, GOWER Street, W C 1 Applications for admission to the B Sc (Special) Course in Zoology, commencing in October, 1955, must reach the Registrar not later than Friday, February 25, 1955 Selected applicants (who will be notified individually) will be required to take a written and practical test in the Department of Zoology on Friday March 25, 1955, from 10 a m to 5 p m The final selection of candidates for admission will, with certain exceptions, be made from those successful in this test

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive unless he or she, or the employment is excepted from the provisions of the Notification of Vacancies Order,* 1952

COMMONWEALTH of AUSTRALIA

DEPARTMENT OF SUPPLY
AERONAUTICAL RESEARCH LABORATORIES
FISHERMEN'S BEND, VICTORIA

Applications are invited for a temporary position of Senior Experimental Officer at the above laboratories Salary £A 1 352 to £A 1 442 per annum Duties Responsible for initiating, planning and conducting experimental projects related to the strength of aircraft materials and components and for developing and improving experimental methods and equipment Qualifications A degree or diploma in engineering or science, or equivalent with passes in pure and applied mathematics I, physics I metallurgy I and strength of materials A sound knowledge of theoretical stress analysis and several years' experience in an engineering laboratory essential Engineering drawing and design experience an advantage Whilst the position is a temporary one the tenure of employment is not limited Under specified conditions, first-class boat fare (if first-class berth available) for the appointee and dependants (wife and dependent children) will be paid by the Commonwealth

Application forms obtainable from Senior Representative (AP 25) Department of Supply Australia House, Strand, London, W C 2, with whom applications should be lodged by February 5, 1955

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

METALLURGIST RESEARCH OFFICER

Applications are invited for a post as Research Officer in the Mechanical Engineering Research Laboratory of the C S I R, Pretoria, South Africa The salary scale associated with this post is £780 by £48 to £1 020 per annum In addition, a cost-of-living allowance of £234 per annum is payable to married male officers Starting salary according to qualifications and experience Generous leave privileges and five-day week Candidates must be in possession of at least an honours degree in metallurgy or metallurgical engineering, or equivalent qualification The successful candidate will do research work in the field of ferrous and non-ferrous physical metallurgy The successful candidate will be required to furnish a medical certificate of good health and to become a member of the University Institutions Provident Fund The Council will bear the transportation costs of the appointee and his family from his place of residence to Pretoria Further information and application forms are obtainable from the South African Scientific Liaison Officer, Africa House, Kingsway, London W C 2

Applications, giving full details of age, marital status, qualifications, experience and the names of referees, must reach the Secretary/Treasurer, C S I R P O Box 395 Pretoria, South Africa, before March 15 1955 A copy of the application must be sent to the South African Liaison Officer in London

---

CHELSEA POLYTECHNIC

MANRESA ROAD, S W 3
HEAD OF DEPARTMENT OF GEOLOGY

The Governors invite applications for the post of Head of the Department of Geology, which becomes vacant through the retirement of Dr W F Fleet Candidates should possess high qualifications in geology, and have had experience in both teaching and research Salary scale, Grade II (men, £1 065 by £25 to £1 215, women £852 by £20 to £972) plus London allowance of £36 or £48 according to age Duties to commence September 1, 1955

Further particulars and form of application may be obtained by sending stamped, addressed foolscap envelope to the undersigned, to whom applications must be returned not later than February 28, 1955

N M H LIGHTFOOT, M A, F R S E
Principal

ST THOMAS'S HOSPITAL MEDICAL SCHOOL

A Lecturer in Applied Pharmacology and Therapeutics is required by the Department of Therapeutics Salary will be according to the scale for a Junior Lecturer or Lecturer according to experience, with family allowance

Applications giving full particulars and the names of two referees, should be sent before February 8 to the Dean, St Thomas's Hospital Medical School, London, S E 1

CHESTER BEATTY RESEARCH INSTITUTE (Institute of Cancer Research Royal Cancer Hospital) Two Technicians required (a) Biochemical technician preferably with experience of manometric techniques or in the isolation of natural products, (b) Technician for physical chemistry laboratory, for work particularly concerned with spectroscopic techniques, experience in this field would be an advantage Both posts are permanent and superannuable, and the salary will be according to age experience and qualifications—Applications, marked respectively "Biochemistry" and "Spectroscopy" should be addressed to the Chester Beatty Research Institute, Fulham Road London S W 3

LONDON TRANSPORT INVITE APPLICATIONS for experienced chemists for Senior Scientific Assistant post Central Laboratory Chiswick, with responsibility for section concerned with wide variety of analytical and investigational work, dealing with detergents, cleaning materials, effluents water treatment, weed killing disinfectants, insecticides, adhesives fire extinguishing materials textiles and leathercloths, preparation and revision of material specifications etc Good honours degree or equivalent qualification experience in industry ability to prepare correspondence and reports Salary range £980 by £25/£50 to £1,180 Commencing salary according to qualifications and experience, medical exam, contributory superannuation scheme after probation—Applications to Staff Officer (F/EV 507), London Transport, 55 Broadway, S W 1 For acknowledgement enclose addressed envelope

---

GOVERNMENT OF NORTHERN IRELAND

INDUSTRIAL USE OF ATOMIC ENERGY
APPOINTMENT OF AN ENGINEER FOR SPECIAL TRAINING

Applications are invited from Engineers with suitable qualifications for an appointment under the Ministry of Commerce for Northern Ireland in connection with developments in the use of nuclear energy in the generation of electricity The appointment will be conditional upon the acceptance of the selected candidate by the Atomic Energy Authority for a course of instruction to which he will be presented by the Ministry, and continued employment will be dependent on satisfactory completion of that course The appointment will be on a contract of service for a period of six years in the first instance, during which the officer may be required to serve on loan, with any statutory body in Great Britain or Northern Ireland designated by the Ministry The contract of service may be extended, or may be terminated by agreement, to enable the Engineer to take up a permanent appointment in the service of the Electricity Board for Northern Ireland The Engineer will be expected, when required, to take part in the design and construction of an electric power station to operate on nuclear energy in Northern Ireland and to take charge of its operation when completed, and he may accordingly expect to be offered a permanent appointment at that stage at latest Candidates should hold an honours degree in engineering or physics of a recognized university, and if the degree is not in physics other evidence of an adequate knowledge of this subject should be furnished Corporate membership of at least one of the institutions of civil, mechanical, or electrical engineers or evidence of an early expectation of obtaining it, will also be required Pay on appointment will be at the rate of £1,000 a year, and, on completion of training, will be at the rate of £1,200 a year, which may be increased from time to time up to a maximum of £1 500 a year, according to the nature of the work Special allowances for accommodation, etc, while in attendance at the course of instruction and while serving on loan will be considered if the circumstances require

Application forms may be obtained from the Director of Establishments Ministry of Finance, Stormont, Belfast, and must be returned, duly completed with copies of two recent testimonials so as to reach him not later than February 8, 1955

COMMONWEALTH of AUSTRALIA

DEPARTMENT OF SUPPLY
AERONAUTICAL RESEARCH LABORATORIES
FISHERMEN'S BEND VICTORIA
SENIOR SCIENTIFIC OFFICER
(Temporary position)

Salary £A 1 502 to £A 1 688 per annum Duties Responsible for the investigation of instrumentation schemes in the field of aeronautical research, for detailed investigation of resultant problems and the subsequent development of necessary apparatus Qualifications University degree of high standard in electrical engineering or physics, with mathematics or mathematical physics to final honours standard or equivalent qualifications and several years' experience of research in the above or an allied field A knowledge of analogue to digital conversion systems or servo-mechanisms and automatic control systems would be an advantage Under specified conditions first-class boat fare (if first-class berth available) for the appointee and dependants (wife and dependent children) will be paid by the Commonwealth

Application forms obtainable from Senior Representative (AP 24) Department of Supply Australia House, Strand London, W C 2 with whom applications should be lodged by February 5, 1955

HERTFORDSHIRE COUNTY COUNCIL

HATFIELD TECHNICAL COLLEGE
Principal W A J Chapman M Sc (Eng), Ph D, M I Mech E, M I P E

Required to commence duties April 1, 1955, or as soon as possible thereafter, Laboratory Steward with recognized qualifications and with special interest in physics Some experience in a teaching laboratory is desirable Salary on N J C scales for local authorities' miscellaneous classes of officers, Grade III and IV, £395 to £520 per annum

Applications, giving qualifications and experience and names of two referees, to the Registrar, Hatfield Technical College, Roe Green, Hatfield, Herts

MILK MARKETING BOARD FOR NORTHERN IRELAND

Applications are invited from suitably qualied persons for the undernoted posts in the Milk larketing Board for Northern Ireland The osts will be permanent subject to a probationary od of two years Candidates must be of ritish nationality Preference will be given to ersons who served in H M Forces during the 914-18 or 1939-45 wars General Manager pplicants must have had considerable experience a senior administrative capacity of the probems undertaken in a large-scale marketing organation preferably in connection with milk The ccessful applicant will be responsible, subject the directions of the Board for the general ontrol of all the Board's activities Salary will e on the scale of £2 000 to £2,400 per annum ccountant and Finance Officer The applicant ust be a member of an Institute of Chartered ccountants the Society of Incorporated Accoun ants or the Association of Chartered and Cororated Accountants Preference will be given to ersons with experience of costing commercial rocesses, and who have experience of the operaon of mechanized accounting Salary will be on e scale of £1,200 to £1 500 per annum Adinistrative Officer The successful applicant will responsible to the General Manager for the dministrative and clerical work of the Board pplicants must have had considerable experience similar capacity preferably in connection the milk industry Salary will be on the le of £1 200 to £1 500 per annum Techal Officer Applicants must hold qualifications dairy technique and in the manufacture of milk oducts It would be to the applicant's adntage if he has had experience in organising ilk transport on a large scale Salary will on the scale of £1 200 to £1,500 per annum or any of the above posts the Board may pay commencing salary above the minimum to speally qualified persons

Applications must be made on the prescribed rm copies of which may be obtained from the cting Secretary Milk Marketing Board for orthern Ireland, Castlehill Road, Belfast, orthern Ireland The latest date for the receipt applications will be January 31 1955

AUSTRALIAN NATIONAL UNIVERSITY

JOHN CURTIN SCHOOL OF MEDICAL RESEARCH

Applications are invited from organic chemists r the position of Research Fellow who will a research assistant to the Professor of Medil Chemistry Candidates should have a Ph D gree (or equivalent research experience) The ccessful applicant will undertake full-time rearch in laboratories which are well equipped r the purpose on the synthesis of new heteroclic compounds, in particular pteridines, pyriidines and purines The appointment will for one, two or three years in the first stance and if the appointment is made for period longer than one year, the successful plicant will later be required to transfer to anberra with the Department The Department s laboratories are at present located at 183, uston Road London N W 1 The salary range £1,100 to £1 650 and superannuation will be vided on the F S S U pattern

Further particulars and information as to the ethod of application may be obtained from e Secretary Association of Universities of the itish Commonwealth 5 Gordon Square, Lonn W C 1 with whom applications close on bruary 28 1955

CENTRAL RESEARCH ESTABLISHMENT ational Coal Board (at Isleworth Middlesex) ich is concerned with mining problems invite plications for the superannuable appointment a Physicist to lead a group carrying out rerch on coal ploughing The work will be ncerned initially with a study of the internal ess distribution and breakage pattern induced a brittle solid containing internal weaknesses the application of a localized continuous or pulsive force Candidates should have a good nours degree in physics or similar professional alifications proved research ability and preferly some experience of stress analysis Appointent will be as Scientist Grade I (scale £1 150 by 0 to £1 350 thence by range to £1 550 male us London location allowance of £82 minimum g to £100 at maximum) —Write giving full rticulars (in chronological order) of age educan qualifications and experience (with dates) National Coal Board Establishments (Personl) Hobart House Grosvenor Place London, W 1 marking envelope TT/906 Original testionials should not be forwarded Closing date bruary 16, 1955

ROWETT RESEARCH INSTITUTE

Applications are invited for the following posts for research on the nature of host parasite relationships (1) Bacteriologist particularly to study the role of antibodies in immunity (2) Pathologist or Histologist, who would also be responsible for problems concerned with histology and morbid anatomy Both posts will be in the Scientific Officer or Senior Scientific Officer grades with initial placing according to age qualifications, and experience, and superannuation under F S S U Salary scales (men) Scientific Officer, £445 to £815, plus supplement £22 10s to £30, Senior Scientific Officer, £935 to £1 090 plus supplement £35 The rates for women are slightly lower

Applications, stating date of birth with particulars of education qualifications and experience together with the names of three referees should be sent to the Secretary, Rowett Research Institute Bucksburn, Aberdeenshire, as soon as possible

NATIONAL VEGETABLE RESEARCH STATION

WELLESBOURNE, WARWICK

ANALYTICAL CHEMIST

Applications are invited for the above post, to work mainly on the analysis of plant material Candidates should have a degree in chemistry or at least the higher national certificate in chemistry Salary in the Assistant Experimental Officer grade £288 per annum at 18 rising to £640 per annum for men or £540 per annum for women Starting salary according to age Superannuation scheme

Applications (four copies), with names and addresses of three referees to the Secretary by February 5, 1955

UNIVERSITY OF QUEENSLAND

AUSTRALIA

Applications are invited for two posts in the Department of Veterinary Clinical Studies (i) Chief Lecturer or Senior Lecturer in Veterinary Clinical Medicine, (ii) Senior Lecturer or Lecturer (Grade I) in Veterinary Clinical Medicine The successful applicant for the senior post will be expected to be responsible for organizing teaching and research in this subject The salary ranges are £A 1 800 to £A 2 050 per annum for Chief Lecturer £A 1,500 to £A 1 750 per annum for Senior Lecturer and £A 1,275 to £A 1,450 per annum for Lecturer (Grade I)

Further particulars are obtainable from the Secretary, Association of Universities of the British Commonwealth 5 Gordon Square London W C 1 Applications close in Australia and London on February 19 1955

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

Principal H Baker Ph D, A M I C E, A M I Mech E

Applications are invited for the post of Assistant Lecturer, Grade B in Physics Applicants should possess an honours degree in physics and be able to teach the subject up to B Sc degree level and mathematics up to advanced level Preference will be given to candidates able to take one branch of physics up to B Sc (special) standard Salary will be in accordance with the Burnham Scale for Technical Teachers which for Assistants Grade B is at present £525 to £820 (men) £475 to £655 (women together with degree and training allowances in appropriate cases

Further particulars and forms of application may be obtained from the Registrar Nottingham and District Technical College Shakespeare Street Nottingham to whom they should be returned not later than January 31 1955

F STEPHENSON,
Clerk to the Joint Education Committee

UNIVERSITY OF CAMBRIDGE

Applications are invited for a University Demonstrator in Physics The Demonstrator will hold office from October 1 1955 and applications close on Saturday, February 19 1955

Details of duties salary etc may be obtained from Dr F B Kipping Chemical Laboratory, Pembroke Street Cambridge

---

SENIOR BIOCHEMIST REQUIRED FOR three-year appointment in mental deficiency research at Fountain Hospital Tooting with additional technical facilities at Galton Laboratory W C 1 in the first instance Whitley Council conditions of service Salary £835 rising to £1 080 plus £40 London weighting —Applications with qualifications and experience to Group Secretary, Fountain Hospital, London, S W 17

WEST AFRICAN COCOA RESEARCH INSTITUTE

A vacancy exists in the Institute for an Agronomist (Scientific Officer or Senior Scientific Officer) to assist in laying down field experiments on various methods of cultivating cocoa Qualifications Candidates must possess at least a second-class honours degree with not less than two years' appropriate postgraduate experience preferably including acquaintance with tropical tree crops and up-to-date knowledge of the statistical analysis of field experimental results Terms of Appointment On probation on terms applicable to the Research Branch of Her Majesty's Oversea Civil Service Emoluments These consist of salary and overseas research allowance in the following ranges Scientific Officer, £860 to £1,057 a year, Senior Scientific Officer, £1 162 to £1,472 a year Point of entry into the basic salary scales depends upon age, qualifications and experience For appointment to the Senior grade suitably qualified candidates must have had at least three years' approved postgraduate experience and be not less than 26 years of age Outfit allowance of £60 on first appointment Contributory superannuation scheme Government quarters when available at rental of 10 per cent of basic salary (maximum £150 a year) Free passages for officer wife and children under 13 years of age on appointment and leave Taxation at local rates

Apply with brief particulars, to the Director of Recruitment, Colonial Office, Sanctuary Buildings Great Smith Street, London, S W 1, quoting reference BCD 197/200/05

SOUTH PACIFIC COMMISSION

PLANT AND ANIMAL QUARANTINE OFFICER

Applications are invited for the post of Plant and Animal Quarantine Officer with the South Pacific Commission The successful applicant will be appointed for a period from two to three years, and will be stationed at the Commission's headquarters in Noumea New Caledonia The Plant and Animal Quarantine Officer is required to carry out investigations, etc, relating to the control of plant and animal pests diseases, and weeds in the South Pacific including supervision of a rhinoceros beetle research programme, operation of an information centre and reporting service and improvement of control and protective measures Applicants should have a university degree with good scientific qualifications and mature experience in the field of plant or animal pests or diseases and their control and prevention including quarantine measures Fluency in English and French is very desirable Commencing salary will be determined according to qualifications and experience but will be not less than £Stg 1 600 plus a post allowance of £Stg 540 (single) or £Stg 901 (married)

Further information obtainable from the Secretary-General South Pacific Commission, Noumea New Caledonia to whom applications supported by a detailed curriculum-vitae should be sent by March 31 1955

VICTORIA UNIVERSITY COLLEGE

WELLINGTON NEW ZEALAND

Applications are invited for a Senior Lectureship in Physical Chemistry The salary will be £1 092 8s per annum rising by annual increments of £50 to £1 292 8s per annum The initial salary will be determined according to the qualifications and experience of the appointee Approved fares to Wellington will be allowed for the appointee, his wife and his children The successful applicant would be expected to take up his duties on May 1, 1955 or at such other date as may be agreed upon

Further particulars and information as to the method of application may be obtained from the Secretary Association of Universities of the British Commonwealth 5 Gordon Square, London W C 1 The closing date for the receipt of applications in New Zealand and London, is March 1 1955

HOMERTON COLLEGE

CAMBRIDGE

Applications are invited for September, 1955, or earlier for the post of Senior Lecturer in Science, who will be required to undertake direction of a Supplementary Science Course Candidates should have good qualifications and recent teaching experience, in either physics or chemistry The post offers scope for scientists interested in planning and carrying through a new course for prospective teachers of general science in secondary schools

Application forms and further details are available from the Secretary to whom applications should be sent before February 10

COMMONWEALTH of AUSTRALIA

DEPARTMENT OF SUPPLY
DEFENCE STANDARDS LABORATORIES
MARIBYRNONG, VICTORIA

Applications are invited for a temporary position of Principal Scientific Officer at the above laboratories Salary £A 1,688 to £A 1,874 per annum Duties To direct research and development in physical optics and optical instrument technology Qualifications University degree of high standard in physics, together with extensive relevant research experience, and proved capacity to initiate and conduct research in these fields Whilst the position is a temporary one, the tenure of employment is not limited However, the successful applicant may choose to enter into an agreement for a three- to five-year contract of employment in Australia In this case, the Commonwealth will bear return fare, together with cost of removing each way the appointees' furniture and effects up to a maximum cost of £A 500 Under specified conditions, first-class boat fare (if first-class berth available) for the appointee and dependants (wife and dependent children) will be paid by the Commonwealth

Application forms obtainable from Senior Representative (AP 26), Department of Supply, Australia House Strand London, W C 2, with whom applications should be lodged by February 5, 1955

UNIVERSITY OF WALES

Applications are invited for two I C I Research Fellowships in physics, chemistry, pharmacology metallurgy, engineering, geology or agricultural science, or in a subject allied to these The Fellowships, normally tenable for three years from October 1, 1955, will be held within the University of Wales One Fellowship shall be tenable at the University College of Swansea the other may be held at any of the constituent Colleges of the University or at the Welsh National School of Medicine The salary will depend upon qualifications and experience, but will be within the range of £600 to £900, together with F S S U benefits and family allowances

Further particulars may be obtained from the Registrar of the University of Wales University Registry, Cathays Park, Cardiff, by whom applications must be received not later than March 31, 1955

UNIVERSITY OF MANCHESTER

TURNER AND NEWALL RESEARCH FELLOWSHIPS

Applications are invited for the above Research Fellowships, founded by Messrs Turner and Newall, Ltd , tenable in the University and available for research in engineering inorganic chemistry physics and allied subjects The value of the Fellowships will be within the range of £600 to £900 per annum according to qualifications and experience

Regulations governing the award of the Fellowships may be obtained from the Registrar The University, Manchester, 13 to whom applications should be sent not later than April 30, 1955

AIR MINISTRY REQUIRES SCIENTIFIC Officers for Operational Research in or near London under direction of Scientific Adviser to Air Ministry Qualifications First- or second-class honours degree or equivalent in mathematics, physics or economics Salary (London) within range £492 10s to £885 Provincial rates and rates for women somewhat lower Posts unestablished with possibilities of establishment through Civil Service Commission for successful candidates whilst remaining under age 31 —Application forms, quoting A 384/54A, from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1

DEPARTMENT OF SCIENTIFIC AND INdustrial Research require an Assistant Experimental Officer (unestablished) at the Food Investigation's Torry Research Station Aberdeen, for work on fish muscle proteins, mainly from the physico-chemical and biochemical viewpoints Candidates must have G C E advanced level in chemistry and physics or equivalent over 22 a pass degree, with chemistry as main subject and physics subsidiary or equivalent will generally be expected An interest in biology or biochemistry an advantage Inclusive annual remuneration for a 45½-hour week within the range £297 (at age 18) to £659 (men) £297 (at age 18) to £556 (women) Prospects of establishment for candidates under 28 —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) Almack House 26 King Street London, S W 1 quoting F 840/54A Closing date February 12, 1955

MAKERERE COLLEGE

UNIVERSITY COLLEGE OF EAST AFRICA

Applications are invited for Assistant Lectureship in Department of Chemistry Salary scale £816 by £36 to £924 per annum Temporary cost-of-living allowance 10 per cent of basic salary F S S U Child allowance £50 per annum per child (maximum £150 per annum) Rent, according to quarters provided, £45 to £85 per annum, including basic furniture Free passages for member of staff and family (up to four adult passages) on appointment, termination and leave (three months every two years)

Applications (six copies), naming three referees, and detailing qualifications and experience, to be received by January 31, 1955, by Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1, from whom further particulars may be obtained

---

ROTHAMSTED EXPERIMENTAL STATION

HARPENDEN, HERTS

Applications are invited for the post of Head of the Department of Entomology The appointment will be in the Senior Principal Scientific Officer grade (£1 600 by £75(3) by £25 to £1,850) Superannuation F S S U The successful applicant will be required to take up duty on October 1, 1955

Applications, together with names of two persons to whom reference may be made, should reach the Secretary by March 31, 1955

GUY'S HOSPITAL

LONDON, S E 1

Applications are invited for the post of Technician (Senior Grade) in the Physics Workshop of the Radiotherapy Department Previous experience in hospital physics workshop desirable

Applications, giving details of age, qualifications and previous experience, together with the names of two referees, should be sent to the Superintendent, Guy's Hospital, on or before January 31, 1955

UNIVERSITY OF CAMBRIDGE

I C I FELLOWSHIPS

Applications are invited for Research Fellowships, value within the range £600 to £900 a year, founded by Imperial Chemical Industries, Ltd tenable in the University and available for research in physics, chemistry, biochemistry, engineering, metallurgy, pharmacology, chemotherapy or related subjects Applications must be received not later than April 30, 1955

Regulations governing the award of the Fellowships may be obtained from the Secretary-General of the Faculties, The Old Schools, Cambridge, to whom all applications should be addressed

---

UNITED SHEFFIELD HOSPITALS

ROYAL INFIRMARY UNIT

Applications are invited from university graduates holding the B Sc (Bact) or B Sc General with bacteriology as one of the subjects for the post of Non-medical Bacteriologist (basic grade) in the Department of Bacteriology Salary during probationary period £410 to £510 per annum, according to qualifications, and after probationary period £585 by £30 to £765 per annum

Applications with the names of three referees, should be addressed to the Superintendent, Royal Infirmary, Sheffield 6

LONDON COUNTY COUNCIL

(1) Assistant Superintendent (2) Collector of Botanical Specimens required for Nature Study Scheme for Schools based at Avery Hill, S E 9 Rates £306 to £701 a year (appointment above minimum as appropriate) and 135s to 154s 6d a week respectively

Application forms with full details, from Education Officer (EO/Estab 2/B), The County Hall, London S E 1, must be returned by February 4 (1687)

RESEARCH ASSISTANT (MAN) WANTED as soon as possible for university work on structure of alloys of high melting point The position offers good opportunities for learning high temperature methods The work is arranged so that the man appointed qualifies as an advanced student for the Oxford D Phil degree Requirements First-class honours degree in metallurgy physics or chemistry Salary according to qualifications Applications from overseas cannot be considered and men with second-class honours should not apply unless they have research experience —Applications to Dr W Hume-Rothery, O B E F R S Inorganic Chemistry Laboratory, South Parks Road Oxford

---

ROYAL COLLEGE OF VETERINARY SURGEONS

APPOINTMENT OF EXAMINERS
DIPLOMA IN VETERINARY STATE MEDICINE

Applications are invited for Examiners to form a panel as under for an examination to be held in Edinburgh in June next Group I Principles of bacteriology and immunity as applied t Veterinary State Medicine (Two) Group I (a) Veterinary hygiene and preventive medicine (One) (b) Food hygiene, including meat an milk inspection and control (One)

Candidates for appointment must make application not later than February 28 1955, and submi statements of their qualifications and copies o any testimonials they may desire to present Fo further particulars please apply to the undersigned

W G R OATES
Registrar

UNIVERSITY OF MANCHESTER

Applications are invited for posts of Lecture in Engineering Civil engineering candidates should have particular interest in elasticity, hydraulics, or surveying , mechanical engineering candidates should have particular interest in hea transfer, fluid mechanics thermodynamics and/o applied mechanics The present salary scale rises to £1,100 per annum, but is under review Initial salary according to qualifications and experience Membership of F S S U and childre allowance scheme Applications will also be c sidered from engineers who would be interest in a temporary appointment of two or m years

Applications should be sent not later tha February 15, 1955, to the Registrar, The Unive sity Manchester, 13, from whom further parti culars and forms of application may be obtained

---

LONDON COUNTY COUNCIL

London School of Printing and Graphic Arts Graduate in Physics or Chemistry, to teach fundamental principles of science and their applicatio to printing photography, paper and ink-making Industrial and/or teaching experience desirable Facilities for research Burnham salary sca grade B, £561 by £25 to £868, plus graduate an training additions (maximum £90 and £54) a applicable Starting salary according to age qualifications and experience

Application forms from the Principal at Bac Hill E C 1 Closing date February 4 (33)

LONDON COUNTY COUNCIL

London School of Printing and Graphic Arts Head of Department of Science and General Education , candidates must be graduates (preferabl science) with administrative experience Th Department covers applied science for whole-tim and part-time students , paper and printing in technology , English, arithmetic and social studie for apprentices Opportunities for research Salary £1,065 by £25 to £1,215, plus Londo allowance (maximum £48)

Application forms from the Principal, at Bac Hill, E C 1 Closing date February 4 (34)

COLLEGE OF ARTS AND SCIENC

BAGHDAD IRAQ

Applications are invited for the post of Reade and three posts of Senior Lecturer or Lecture in Physics Term of appointment to commenc not later than October 1 1955 Salaries are i the range ID 1,400 to ID 2,400 (1 ID =£1), tc gether with a cost-of-living bonus of at leas ID 120 and certain other allowances Passage are paid at beginning and end of contrac Annual summer leave is permitted Persons ap pointed are required to carry on research an to teach candidates for B Sc degree Teaching in English Climate and conditions are suitabl for British families

For further information apply to the unde signed

A A DURI
Dean

MOUNT VERNON HOSPITAL

NORTHWOOD, MIDDLESEX

Technician required for the Physics Departmen Workshop Applicants must be skilled machinis and/or instrument makers Some experience c servicing X-ray therapy equipment would be a advantage Commencing salary within the rang £450 by £15(3) by £20(1) to £515 per annum plu London weighting (age 21 to 25, £20 , 26 an over £30)

Applications with the names of two referee should reach the Secretary and House Governc by February 4, 1955

UNIVERSITY OF BRISTOL

DEPARTMENT OF AGRICULTURE AND HORTICULTURE
RESEARCH STATION, LONG ASHTON, BRISTOL

Applications are invited for the following posts at the Long Ashton Research Station Assistant in Chemistry in the Cider and Fruit Products Section to be appointed under the scheme of the Ministry of Agriculture and Fisheries for research institutes Assistant in Chemistry in the Agricultural Research Council's Unit of Plant Nutrition (micronutrients), at Long Ashton These appointments will be in the Assistant Experimental Officer Grade (£342 at age 20 to £640 for men £342 at age 20 to £540 for women), with superannuation Candidates for each post should possess a recognized qualification in chemistry (minimum qualification, national certificate in chemistry) For the post in the Agricultural Research Council's unit additional qualifications in microbiology will be an advantage

Further particulars may be obtained from the Secretary, to whom applications together with copies of three recent testimonials should be addressed not later than February 12 1955

THE SECRETARY,

Research Station,
Long Ashton, Bristol

UNIVERSITY OF ABERDEEN

Natural Philosophy Department requires man already trained as Glassblower, or prepared to become Glassblower after training University will pay training expenses of suitable candidate Applicants should have done National Service, and should have manual skill Wages in range £315 to £450, according to experience and ability

Applications in writing to the Secretary, Marischal College

EAST MALLING RESEARCH STATION

Botanist required, for work connected with the effect of field factors on fruit characters especially those affecting the storage life of apples Experience in microscopy an advantage The post is in the Ministry of Agriculture's Assistant Experimental Officer grade

Further particulars and application form available from the Secretary, East Malling Research Station near Maidstone Kent, by whom applications should be received not later than February 7 1955

ONTARIO RESEARCH FOUNDATION

CANADA

Chemist preferably not over 30 years of age, is required for physical and chemical research relating to textile industrial operation Two or three years' experience in research or industry desirable

Applications or requests for further information should be addressed to Personnel Officer, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Ontario

---

RESEARCH ASSISTANT SOUGHT BY THE Chemistry Department, University of Birmingham, to design and construct research electronic equipment and assist in its use Salary according to experience and qualifications Degree not essential —Applications, stating details of career, to Secretary to the Director, Chemistry Department, The University, Birmingham 15

CARTOGRAPHIC DRAUGHTSMAN (OVER 21) required by The Nature Conservancy Must be experienced draughtsman capable of plotting from aerial photographs and surveyor's notes Knowledge of hand lettering desirable but not essential Starting salary between £342 and £402 (men) according to age Annual increments of £20 to £482 and £15 to £595 Women somewhat less —Applications, giving details of sex, date of birth, education national service, technical training and experience, present appointment, and names and addresses of two referees, one to speak for ability and one for character, must reach the Establishment Officer, The Nature Conservancy 19 Belgrave Square, London, S W 1, before February 11, 1955

JUNIOR TECHNICIAN REQUIRED FOR Histology Experience laboratory work histology or biology an advantage Knowledge photography useful Salary scale £130 to £312 plus London weighting Commencing pay within scale according to qualifications and experience Superannuation scheme —Apply, with full details, to Secretary Royal Veterinary College, Royal College Street N W 1

UNIVERSITY OF MANCHESTER

Applications are invited for a full-time post as Reader or Senior Lecturer in Chemical Pathology Candidates need not be medically qualified, but should have special qualifications in chemical pathology Salary scales are (a) for medically qualified persons, Reader £1 800 by £100 to £2,250, Senior Lecturer £1,800 by £100 to £2,000, (b) for non-medically qualified persons, Reader £1,250 by £50 to £1,600, Senior Lecturer £1,150 by £50 to £1,500 (salary scales are at present under review) Initial salary and status according to qualifications and experience Membership of the F S S U and children s allowance scheme

Applications should be sent not later than February 26, 1955 to the Registrar, The University, Manchester, 13, from whom further particulars and forms of application may be obtained

---

THE UNIVERSITY OF ALBERTA ANnounces the following vacancies in Mathematics (1) Assistant or Associate Professor of Statistics, appointment to be effective September 1 1955, starting salary $5,000 or higher, normal increments $250 (2) Sessional Lecturer in Mathematics for eight months from September 1, 1955, at a gross salary of about $3 600, prospect of permanent appointment —Applications, including transcript of academic record, curriculum vitae, publications, names of two references, and recent photograph or snapshot to be sent to Walter H Johns, Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Canada

---

APPOINTMENTS VACANT

BRITISH RAYON RESEARCH ASSOCIATION

Physical Chemist required, with an interest in thermodynamics and reaction kinetics, to carry out research on dye adsorption by textile materials Applicants should have a good honours degree, with some research experience (not necessarily in textiles) Salary in accordance with age and qualifications Superannuation under F S S U

Applications quoting vacancy reference P C 1 with full details and names of two referees, should be addressed to the Appointments Officer, British Rayon Research Association Heald Green Laboratories, Wythenshawe, Manchester

---

CHEMICAL ENGINEER OR INDUSTRIAL CHEMIST

with plant experience, interested in chemical engineering, is required for the Technical Group of the Company Duties will include process investigation and development and specialized equipment design Permanent appointment carrying pension and life assurance —Write, stating reference N S J5, and details of age, qualifications and experience, to

PERSONNEL OFFICER (STAFF),
MAGNESIUM ELEKTRON, LIMITED,
P O BOX NO 6, LUMM'S LANE,
CLIFTON JUNCTION, SWINTON, NEAR
MANCHESTER

GRADUATE CHEMIST, METALLURGIST or Chemical Engineer required, to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel —Apply, Electro-Chemical Engineering Co, Ltd, 161 Queens Road Weybridge, Surrey

---

BACTERIOLOGIST, WITH UNIVERSITY degree, wanted to take charge of laboratory producing veterinary sera and vaccines Must be experienced in laboratory techniques and have had at least two years' practical experience Knowledge of veterinary work an advantage, but not essential —Box 619, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

ENGINEER AGED 22/35 REQUIRED BY Cable Company in London area for testing and maintenance of electronic equipment in new instruments for automatic testing of telecommunication cables —Apply, giving full particulars to Box 618, T G Scott and Son Ltd, 143-147 Regent Street, London, W 1

LADY CHEMIST, GRADUATE OR H N C, required for analysis of electroplating and allied solutions —Apply, Electro-Chemical Engineering Co Ltd 161 Queens Road, Weybridge, Surrey

---

THE BRITISH CERAMIC RESEARCH Association has vacancies for honours graduates in physics or chemistry, for work on a wide range of problems in the ceramic industry Previous experience in this field is not essential The appointments, which carry superannuation under F S S U, are permanent and offer good prospects Salary will depend on age, qualifications and experience, but will be within the range £450 to £800 for Scientific Officers, and £830 to £1,070 for Senior Scientific Officers —Applications, together with full details should be sent to the Director of Research, Queens Road, Penkhull, Stoke-on-Trent

---

RESEARCH METALLURGIST REQUIRED to undertake investigations on metallurgical problems associated with the machining and cold forming of metals Candidates should possess a good degree The position is permanent and there are good prospects for advancement Superannuation scheme in operation —Send full details, including age, experience, qualifications and salary required to Box 614, T G Scott and Son, Ltd 143-147 Regent Street, London W 1

WANTED A MAN TO TAKE CHARGE OF a new division on nuclear pile instrumentation The division is small at the moment but expected to expand considerably in the coming years and a very attractive career is offered to the right man Experience in servo systems and electronic circuitry is essential —Particulars, quoting reference R13, to the Personnel Officer, Ericsson Telephones Limited Beeston, near Nottingham

---

ORGANIC RESEARCH CHEMIST REquired by company manufacturing fine and technical chemicals The work will be mainly on hydrogenation of aromatic compounds, with particular reference to stereochemistry of products Honours graduates preferred, some industrial research experience desirable Initial salary up to £850 The post can be regarded as permanent and pensionable —Apply in writing, stating age and giving details of education and experience to Personnel Manager, Howards of Ilford, Ltd Ilford Essex

---

SENIOR TECHNICIAN, WITH EXPERIENCE in biochemistry and/or biology required for position of Research Assistant to the Research Manager of a company manufacturing pharmaceutical and medicinal preparations The post is a responsible one, and calls for a first-rate thorough worker, possessing keenness and initiative Contributory pension scheme —Apply to Secretary, Benger's, Limited, Holmes Chapel Cheshire

---

ELECTRON MICROSCOPE LABORATORY Assistant, male or female, educated to Inter Science or higher school certificate standard required in Record Division of Electric and Musical Industries, Ltd, to operate electron microscope for purposes of production control and research Work is delicate and calls for dexterity in preparing specimens Previous experience a recommendation, but not essential Free training to selected applicant —Write, stating age, education and previous experience, to Personnel Dept (WL) E M I, Ltd, Blyth Road Hayes, Middlesex

---

A PHYSICAL CHEMIST IS REQUIRED BY Johnson & Johnson (Great Britain), Ltd, at the Central Research Division, Slough, for investigations on the surface chemistry of textile fibres and other high polymers Applicants should hold good academic qualifications, and should preferably have had experience in the textile field Commencing salary will be not less than £750 per annum —Applications to Research Director, Research Department, Johnson & Johnson (Great Britain), Ltd, 240-242 Bath Road Slough, Bucks

---

VACANCY EXISTS FOR POSITION AS SECtion Head of Test Set Development, Design and Construction Group Age 25 to 38 years Higher national or City and Guilds telecommunications certificate essential plus detailed knowledge of radio and electronic equipment Experience of R F measurements and test equipment an advantage House could be made available —Apply in writing to the Personnel Manager, Standard Telephones and Cables, Limited, Crystal Division Industrial Estate East, Harlow, Essex

---

BRITISH NYLON SPINNERS, LTD, HAVE a vacancy in their Library and Information Section for a woman graduate in chemistry She will be mainly concerned with assisting members of the Research and Development Departments in their work by carrying out searches in scientific literature, and with the selection of information of interest from new material as it is published Previous library experience is not essential The appointment is permanent and pensionable —Apply in writing to Personnel Manager, Pontypool Mon

MOTOR INDUSTRY RESEARCH ASSOCIATION

DEPUTY DIRECTOR

Applications are invited for the newly-created post of Deputy Director of the Motor Industry Research Association Candidates must have high academic qualifications, wide experience in engineering research and, preferably, some administrative ability and a knowledge of the motor industry A salary up to £2,000 per annum will be paid to a suitably qualified candidate and superannuation provided under the F S S U scheme

Apply in writing, giving full details of qualifications and experience, to Director, Motor Industry Research Association, Lindley, near Nuneaton, Warwickshire

---

STEAM GENERATING PLANT

Considerable opportunities are arising in an established and rapidly growing concern engaged in the design and manufacture of large steam generating plant, including new developments Applications are invited from Engineers under 35 years of age with qualifications and experience in one or more of the following branches

(a) Steam boiler plant design generally
(b) Heat transfer design
(c) Combustion engineering design on all fuels
(d) Structural design

The qualifications under (b) (c) and (d) need not necessarily be in the steam engineering field

Applications, which will be regarded as strictly confidential, should be written in the first instance and addressed to Dr R S Silver, John Brown Land Boilers, Limited Whitecrook Works, Clydebank

---

PHYSICIST REQUIRED BY A RESEARCH group of a well known Company in West London area Applicants should have good academic qualifications and research experience involving infra-red techniques The post offers considerable opportunity for original work and carries excellent salary and prospects —Please write in confidence, with full details, to Box 624, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1

JOSEPH LUCAS, LIMITED, HAVE AN INTERESTING vacancy in their research and development laboratories which would be suitable for a young graduate with honours degree in mathematics or physics The work is largely of a fundamental nature and is concerned with acoustics and mechanical vibrations Previous industrial experience is not necessary —Please reply, giving qualifications, age, and any other relevant details, to Personnel Manager, Joseph Lucas (Electrical) Ltd , Great King Street, Birmingham quoting reference PM/D/59

JOHNSON & JOHNSON (GREAT BRITAIN) Ltd , require a qualified Microbiological Chemist in the Central Research Division, Slough This is solely a research appointment and will not involve routine testing Research experience involving bacteriology and/or mycology is essential Commencing salary according to qualifications and experience —Apply to Research Director, Johnson & Johnson (Great Britain), Ltd , Research Department, 240-242 Bath Road, Slough, Bucks

---

LEADING OIL COMPANY HAVE VACANCY for Chemist in their Head Office Applicants should be in possession of degree or equivalent, and if possible wide experience in the petroleum industry Work to cover lubricants, solvents, bitumens, fuels, etc Age 30 to 35 years Salary according to age and qualifications —Applicants should apply, giving full particulars of qualifications and experience, quoting H 3115 to Box 7204 c/o 191 Gresham House E C 2

PHYSICAL METALLURGIST IS REQUIRED by Imperial Smelting Corporation Ltd , for laboratory investigational work on alloys This is a Senior Staff appointment in the Research Laboratory of the Organization and applicants should possess a degree in metallurgy or equivalent qualification and not less than one years' industrial experience in physical metallurgy work Commencing salary will be dependent on individual qualifications and experience and applications should be submitted to Personnel Manager, Imperial Smelting Corporation Ltd , St Andrew s Road Avonmouth quoting reference MRL/N

RESEARCH AND DEVELOPMENT Ferodo, Limited, have vacancies for both Technical Assistants and graduate Technical Officers The Assistants should preferably have advanced level G C E in physics or chemistry, while some industrial experience, particularly of moulding or related technologies, would be advantageous The work is concerned with the development of various types of friction products and offers good opportunities for men with initiative and enthusiasm for the development of products in a new field Contributory pension scheme compulsory —Applications giving full details of age, education, industrial experience etc , and quoting T/RAD, to Personnel Manager, Ferodo, Limited, Chapel-en-le-Frith, via Stockport

---

MEDICAL REPRESENTATIVES BRITISH subsidiary of leading American ethical pharmaceutical house have vacancies in several areas for Medical Representatives Good starting salary and expenses Car provided —Applications with full particulars of age, qualifications, experience and salary required, in writing only, to the Manager, Pfizer, Ltd , 137-139 Sandgate Road, Folkestone, Kent

---

THE B T H COMPANY HAVE A vacancy in their Research Laboratory for a Chemist or Physicist to engage in the preparation and processing of silicon for use as a crystal rectifier at ultra-high frequency —Applicants should possess a degree in physics or in chemistry and should write, giving their age and other particulars to the Director of Research, British Thomson-Houston Co , Ltd , Rugby, quoting Reference ATJ

PROFESSIONALLY QUALIFIED ENGINEERS and Physicists are required to explore and develop new circuits based on transistors —Applicants should write to the Director of Research British Thomson-Houston Co , Ltd Rugby, quoting reference BR and stating their age qualifications and experience

---

THE B T H COMPANY HAVE vacancies in their research laboratory for Assistants in the production, treatment and processing of silicon in very pure form Applicants should have some chemical knowledge and preferably hold a national certificate in chemistry or physics —They should write, giving their age and other particulars to the Director of Research British Thomson-Houston Co , Ltd , Rugby, quoting reference ON

TECHNICAL SALES REPRESENTATIVE, age 25 to 32 of good approach, required by well known Company, to specialize in non-selective weed control products Knowledge of soils, weeds and mechanical appliances desirable Five-day working week —Apply in writing, stating qualifications and salary required, to Box 8253, c/o Charles Barker & Sons Ltd , 31 Budge Row, London, E C 4

ANALYTICAL CHEMIST THE BRITISH Drug Houses Ltd , Graham Street, London, N 1, require an Analytical Chemist for work on the analysis of organic pharmaceutical compounds Candidates should be of B Sc standard Previous experience desirable but not essential Salary according to qualifications and experience Five-day week, canteen, sports club, pension and profit sharing schemes —Write, stating age, experience, if any to the Staff Manager

---

APPLICATIONS ARE INVITED FROM RECENTLY qualified male Chemists for interesting progressive post in cereal laboratory Work will involve non-routine analysis and research Applicants should be in 20 to 25 age group Five-day week and pension scheme in operation —Write, giving full particulars of academic qualifications and experience to Personnel Manager (L), Quaker Oats, Limited Bridge Road, Southall, Middlesex

---

ENGINEER AGED 25 /35 WITH ELECTRICAL or physicist degree required by Cable Company in London area for development work on testing equipment for telecommunication cables Permanent and pensionable position at salary commensurate with experience and qualifications —Apply, giving full particulars to Box 617 T G Scott and Son, Ltd , 143-147 Regent Street, London W 1

AN INFORMATION SCIENTIST IS REQUIRED for the Central Research Department of the Morgan Crucible Co , Ltd A good degree, preferably in general science, is essential, and a knowledge of French and German would be useful The successful applicant must be able to prepare lucid reports on a wide variety of scientific subjects, and (a) collect and disseminate scientific information , (b) take an active and direct part in all research projects in advising research workers and keeping them up to date with information relevant to their particular project , (c) administer the Technical Library and Information Department —Details of experience, age and qualifications should be sent to the Staff Manager, Battersea Church Road S W 11

IMPERIAL SMELTING CORPORATION Limited has vacancy for Inorganic or Physical Chemist to work on problems of pigments manufacture in research laboratory Applicants should possess minimum second-class honours degree in chemistry and should preferably have two to three years' research experience Commencing salary will be fixed according to individual qualifications and experience —Applications in first instance, quoting reference CMP/N, to Personnel Manager, Imperial Smelting Corporation Ltd , St Andrews Road, Avonmouth, Bristol

---

IMPERIAL SMELTING CORPORATION has a vacancy for a Group Leader in Surface Chemistry Section of Research Laboratory to supervise a small group carrying out research i vestigations on the surface chemistry of pigment Applicants should possess an honours degree i chemistry and knowledge or experience in surfac chemistry, colloid chemistry or related fields — Applications, quoting reference GLS/N, tc Personnel Manager, Imperial Smelting Corporation Ltd , St Andrew's Road, Avonmouth, Bristol

---

ENGINEER WANTED BY IMPERIAL Chemical Industries Ltd , Alkali Division, Winnington, Northwich, Cheshire, to do research on industrial chemical operations such as heat transfer and matter transfer Candidates aged 25-35 should possess an honours degree in engineering (preferably mechanical) and have received such practical training as is required for Associate Membership of the major Engineering Institutions Starting salary according to age and experience — Applications, giving details of age and experience should be addressed to Staff Manager

---

THE WELLCOME FOUNDATION LIMITED invites applications from graduates, either men or women, for posts as Biochemists at the Wellcome Research Laboratories (Biochemical Division), Beckenham, Kent Applicants should possess an honours degree in biochemistry and should preferably have some knowledge of physiology Salary will be in accordance with age, experience and qualifications —Applications should be made in writing to the Head of the Biological Division, The Wellcome Research Laboratories, Beckenham Kent

---

ENGLISH ELECTRIC CO , LTD , WISH TO extend their present laboratory facilities for study of the effect of environmental conditions on guided weapons and their components Applications are therefore invited from Senior an Junior Engineers to direct and carry out it work A wide variety of electrical, mechanical and physical testing is under consideration, and, although previous experience of guided weapons is desirable, it is by no means essential The possession of an engineering or physics degree, H N C , or similar qualification coupled with some experience in designing and handling ingenious electrical and mechanical test contrivances, would form a satisfactory qualification Housing assistance can be given if required —Please write stating age, experience and qualifications, to Dept C P S , 336-7 Strand, W C 2 quoting Ref 1000E

IMPERIAL CHEMICAL INDUSTRIES, DYESTUFFS Division, have a vacancy in their laboratories in the Manchester district for a young woman honours graduate who has specialized in biological science, preferably with some experience in microbiology The appointment is concerned with biological control and the manufacture of antibiotics —Applications, giving full particulars of age, qualifications and experience should be addressed to the Staff Department Hexagon House, Blackley, Manchester 9

APPLICATIONS ARE INVITED FOR POSTS in a development laboratory located in Northamptonshire Minimum qualification required is a degree in physics or the equivalent Experience in microwave work would be advantageous —Box 628, T G Scott and Son, Ltd , 143-147 Regent Street London W 1

A PROFESSIONALLY QUALIFIED Engineer or Physicist is required for the development of electrical spark erosion methods as applied to the cutting of hard metals —Applicants should write to the Director of Research British Thomson-Houston Co , Ltd , Rugby, quoting reference BL and stating their age qualifications and experience

WELL-KNOWN COMPANY LOCATED west of London requires a Librarian for its expanding Research Department Duties will consist essentially of the collation, indexing and dissemination of technical information Candidates should preferably hold a degree in chemistry and have had experience in literature research Detailed knowledge of cataloguing and indexing methods is essential This is a new and responsible post, and attractive salary, commensurate with qualifications and experience, will be paid —Write Box N 941, LPE 55 St Martin's Lane, W C 2

IMPERIAL CHEMICAL INDUSTRIES LTD , has a vacancy for a male Assistant Botanist for research on plant growth regulators Candidates must be under 30 and hold an honours degree in botany Some plant physiological research experience is essential —Write with details of education, qualifications and experience to the Secretary, Jealott's Hill Research Station Imperial Chemical Industries, Ltd Bracknell, Berks, before January 31, 1955

INDUSTRIAL ORGANIZATION CONcerned with application of photographic processes and apparatus requires a first-class Senior Assistant to undertake comprehensive duties in its Patent Department Interests are world-wide An extensive knowledge of patent procedures is necessary —Write Box 626 T G Scott and Son, Ltd , 143-147 Regent Street London W 1

ASSISTANT STATISTICIAN WITH DEGREE in mathematics and/or statistics (or equivalent) required, for work in connection with development—and production—investigations He/she will be directly responsible to the Company's Industrial Statistician Previous experience not essential The post offers excellent prospects and carries senior staff status Contributory pension scheme —Applications, giving details of age education, qualifications, etc , and quoting reference T/AS to Personnel Manager, Ferodo, Limited Chapel-en-le-Frith, Via Stockport

YOUNG MEN OF GRADUATE STANDARD in science required as Shift Technicians Interesting and responsible positions with scope for advancement Some knowledge of photography an advantage Non-contributory pension and insurance plan —Apply by letter to Personnel Department Kodak, Limited (Factories), Wealdstone, Middlesex

APPLICATIONS ARE INVITED FOR THE appointment of Chief Development Engineer by established Electrical and Scientific Instrument Manufacturers Candidates must possess good academic qualifications and have extensive experience in the design and development of light electro-mechanical and electronic precision instruments The post is an important one carrying with it the responsibility of control and administration of existing staff of physicists engineers, drawing office and prototype personnel —Applications which will be treated in strict confidence, should state details of qualifications, experience, etc , and be addressed to the Managing Director R B Pullin and Co Ltd , Phoenix Works, Great West Road, Brentford, Middlesex

BIOCHEMIST THERE IS A VACANCY for a Biochemist in the Wellcome Laboratories of Tropical Medicine The work of this appointment consists mainly in the investigation of problems relating to the action of chemotherapeutic drugs, and experience in this or some similar field is essential The salary offered will be governed by the age and qualifications of the candidate —Applications should be addressed to the Secretary, Wellcome Laboratories of Tropical Medicine (The Wellcome Foundation, Ltd), 183 Euston Road London, N W 1

GRADUATES WITH HONOURS DEgree are required by the BTH Co , Rugby for research into the physics of light emission from electric discharges and from incandescent surfaces The work will involve radiation measurement and the experimental development of new light sources —Applicants should write to the Director of Research, British Thomson-Houston Co Ltd , Rugby, giving their age, qualifications and college, quoting reference RH

GLAXO LABORATORIES LTD , YOUNG Writer of sound education with some scientific knowledge required in creative team dealing with interesting scientific material Work includes writing technical literature and articles for medical, veterinary and pharmaceutical professions Literary ability, enthusiasm and lively interest in medical developments essential , background in physiology or allied fields could be valuable Superannuation and incentive schemes —Apply with specimens of original writing, if available to Senior Personnel Officer, Glaxo Laboratories Ltd , Greenford, Middlesex

CHEMIST OR PHYSICIST GRADUATE preferred, with some industrial experience, to assist in development of sub-miniature electronic components Knowledge of new materials and processes and their applications in this field is desirable —Write, giving details of experience and salary required, to Manager, Component Division, Fortiphone, Ltd , 247 Regent Street London, W 1

Advertisers please note You must add "Apply Employment Exchange" unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

BRITISH NYLON SPINNERS, LIMITED The Company's expanding activities will give rise to further appointments, during the next few months, covering a wide field of scientific endeavour Graduate Scientists and Textile Technologists whether available now or later, are invited to register their interest at this stage and where necessary exploratory interviews will be arranged involving no obligation The openings will cover a range of work including pure research, applied research plant experimentation and the development of new manufacturing techniques up to full scale operation For men with suitable ability and inclinations there will be opportunities for specializing in the new advanced forms of technology arising with the advent of synthetic fibres and their textile applications Several of the appointments will be at a senior level, and the Company will welcome tentative inquiries from chemists, physicists and textile graduates —These will be treated in strict confidence, and should be addressed to the Personnel Manager, British Nylon Spinners Limited, Pontypool Mon

A WELL-ESTABLISHED COMPANY WITH a dominant position in its own field requires a man as Assistant to the Manager The first assignment would be to take charge of a small investigating team to review all processes and procedures of the whole manufacturing process with a view to recommending constructive changes A man of proved ability is required who understands people as well as processes preferably he should be not more than 35 years of age with a liberal education and some experience in engineering or physics, though other forms of experience or training are not excluded The first assignment should automatically lead to a position of responsibility and authority and the job will command a good salary —Write Box 627, T G Scott and Son, Ltd 143-147 Regent Street, London, W 1

CHEMIST OR BIOCHEMIST FOR ANAlytical and research work, bacteriological experience an advantage Age 21 to 30 —Box 625 T G Scott and Son, Ltd , 143-147 Regent Street, London W 1

FOR SALE AND WANTED

CORNEAL AND CONTACT LENSES EASY payments arranged if desired —For details and free booklet write David Blackstone, Ltd , Dept 235, Triumph House, 189 Regent Street, London W 1 Tel Regent 3516-7 Consulting Rooms in Leeds, York, Leicester, Middlesbrough, Newcastle etc

---

◄ ◄ ◄ ◄ **GRATICULES**

We are now using so many modern methods of processing scales, masks and other graticules on glass that we can find a solution to most glass engraving and printing problems

PATON HAWKSLEY

ROCKHILL LABORATORIES, KEYNSHAM, SOMERSET
Offices 389 Archway Rd , London, N 6 KEYNSHAM 2364

BRASS • COPPER • DURAL • ALUMINIUM • BRONZE •

ROD, BAR, SHEET, TUBE, STRIP, WIRE

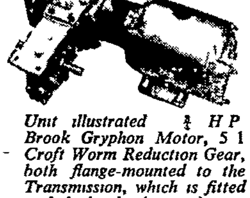
3,000 STANDARD STOCK SIZES

No Quantity too small • List on application

H. ROLLET & CO., LTD.

6, CHESHAM PLACE, LONDON, S W I SLOane 3463
Also at LIVERPOOL, LEEDS, MANCHESTER, BIRMINGHAM

INFINITELY VARIABLE SPEED



Unit illustrated ¼ H P Brook Gryphon Motor, 5 1 Croft Worm Reduction Gear, both flange-mounted to the Transmission, which is fitted with hydraulic (remote) control (Output speed 0-174 r p m max torque 450 lb in)

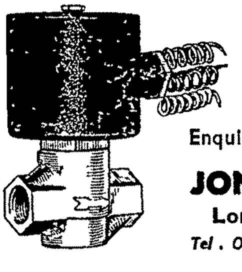
Hydraulic Gears at less than 15% of original cost

Write for full details

Illustrated brochure and long list of famous users sent by return Originally made by Vickers-Detroit at over £230 Each unit transmits up to 2 B H P Zero to 1,240 r p m in either direction Six months' guarantee Units now also supplied complete with electric motors, starters, remote controls, reduction gears, etc , if required

N J TATHAM & CO LTD.
(Dept 6) Lowfield Works · Haywards Heath Sussex

Concordia Valves



SOLENOID VALVES

Temperature and Pressure

CONTROLS

Enquiries for special applications invited

JONES & STEVENS LTD.

Long Lane, Littlemore, Oxford

Tel . Oxford 779/2 Cables Instruments, Oxford

MISCELLANEOUS

ELECTRONICS APPLIED TO INDUSTRY Learn the basic principles and applications with our modern self-study course Experimental work included if required —Free Brochure from E M I Institutes, Dept N 56, London, W 4 (Associated with H M V)

GRANTS & SCHOLARSHIPS

LONDON COUNTY COUNCIL

ROBERT BLAIR FELLOWSHIP IN APPLIED SCIENCE AND TECHNOLOGY

Applications are invited for the award of the Robert Blair Fellowship tenable for one year of advanced study or research abroad in applied science and technology The value of the award is subject to variation, and if the country selected should be Canada or the U S A may be about £1,000, subject to P A Y E deductions Candidates must be British subjects and at least 21 years of age

Further particulars and application forms obtainable from the Education Officer (EO/H1/2), The County Hall, London S E 1 (s a c (foolscap) necessary), and returnable by March 1, 1955 (1659)

NUFFIELD FOUNDATION

SOCIOLOGICAL SCHOLARSHIPS AND BURSARIES

The Nuffield Foundation, in pursuance of its programme for the advancement of sociological studies, is prepared to offer for the academic year 1955-6 a small number of scholarships and bursaries to enable graduates in academic subjects other than the social sciences, psychology or economics, to study the social sciences The Foundation's particular object is to enable men or women, who are already well qualified in other disciplines, particularly the natural sciences or the humanities, to receive a training in for example, political science, social psychology, anthropology, social statistics and sociology generally (but not economics) so that in due course they may undertake research or teaching in the United Kingdom in those subjects The scholarships, which are the senior awards, are intended for persons who have already undertaken some postgraduate work in their own subject The bursaries are intended to enable those who have recently graduated to take a course of training in sociological subjects In the case of both scholars and bursars the Foundation will pay the cost of university and/or college fees in addition to a maintenance award Graduates of universities in the United Kingdom, of either sex and preferably between the ages of 22 and 35, are eligible to apply

Applications for awards in 1955 must be received before May 1, 1955, by the Director, The Nuffield Foundation, Nuffield Lodge, Regent s Park, London, N W 1, from whom full particulars and application forms can be obtained

L FARRER-BROWN
Director of the Nuffield Foundation

THE ROYAL SOCIETY

JOHN MURRAY TRAVELLING STUDENTSHIP IN OCEANOGRAPHY AND LIMNOLOGY

The Council of the Royal Society is prepared to receive applications for the John Murray Travelling Studentship in Oceanography and Limnology The Studentship is open to male British graduates under the age of 35 and is to be used for the encouragement of travel and work in oceanography or limnology The value of the Studentship will be between £500 and £600, and it may be awarded for a period of one year or less It is hoped that students will try to gain practical experience of deep-sea oceanography, as initiated by the Challenger Expedition though this is not a condition of the award, which is available also for limnology for this purpose they can be assisted in arrangements to sail in oceanographic research ships as opportunities arise Students may be enabled also to visit and work at oceanographical institutions and research stations abroad

Applications which should be received not later than February 10 1955 may be made on forms to be obtained from the Assistant Secretary Royal Society Burlington House, Piccadilly, London, W 1

NUFFIELD FOUNDATION

BIOLOGICAL SCHOLARSHIPS AND BURSARIES

The Nuffield Foundation, as part of its pr gramme for the advancement of biological studie is prepared to offer for the academic year 1955- a limited number of scholarships and bursar to enable persons who have graduated in physi chemistry, mathematics or engineering, but wh have had no training in a biological subject, receive such training in biology as will enab them in due course to undertake research a teaching in the United Kingdom in the biologic sciences The scholarships, which are seni awards, are intended for persons who have a ready undertaken some postgraduate research i their own subject The bursaries are intended t enable those who have recently graduated to complete a course of training in biological subject including if considered necessary, a full hono degree course in biology In the case of bot scholars and bursars the Foundation will pay th cost of university and/or college fees in additio to a maintenance award Graduates of universities in the United Kingdom, of either sex an preferably between the ages of 22 and 35, ar eligible to apply

Applications for awards in 1955 must be re ceived before April 1, 1955, by the Director, Th Nuffield Foundation Nuffield Lodge, Regent Park, London, N W 1, from whom further par ticulars and application forms can be obtained

L FARRER-BROWN
Director of the Nuffield Foundatio

SCHOLARSHIPS ABROAD, 1955-5

Applications are invited from British student for Scholarships offered by Austria, Belgium Brazil, Denmark, Finland, France, Germany, Ice land, Italy, The Netherlands, Norway, Persia Portugal, Spain, Sweden, Switzerland and Yugo slavia The awards are mainly for universit graduates and undergraduates, and are tenabl for periods varying from a few weeks to twelv months during the academic years 1955-56 Th closing dates for receipt of applications vary fo each country, the earliest being March 7, 1955

Full particulars and application forms, fo which a stamped, addressed foolscap envelope should be sent, are obtainable from the British Council, 65 Davies Street, London, W 1, or fr any British Council Office in the United Kingdom

OXOID

DEHYDRATED CULTURE MEDIA

QUICKLY PROVIDE SELDOM USED MEDIA

SAVE STORAGE SPACE

Details upon request

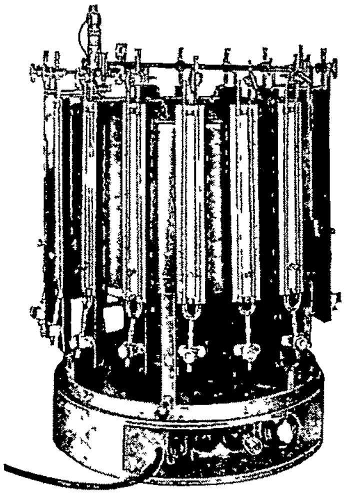
Obtainable from Laboratory suppliers or direct from

OXO LIMITED (Medical Dept) THAMES HOUSE, LONDON, E.C.4.

CENtral 9781

HOSLAB
Regd Trade Mark
Laboratory Equipment

WARBURG
CONSTANT VOLUME RESPIROMETER
(LEAFLET ON APPLICATION)

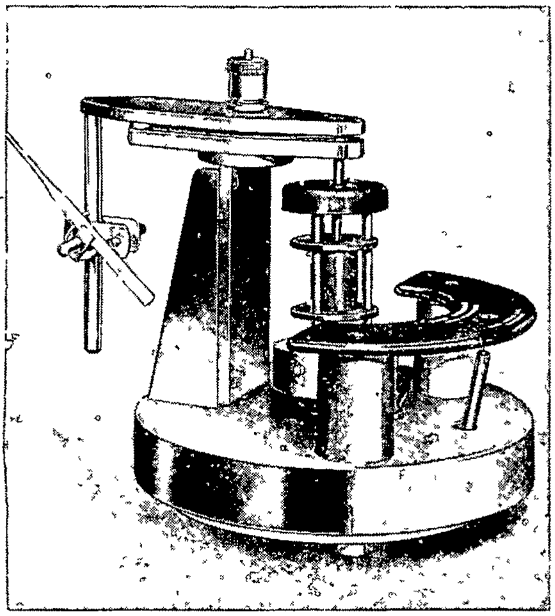


CIRCULAR BENCH MODEL
RECTANGULAR MODEL ALSO AVAILABLE

HOSPITAL AND LABORATORY SUPPLIES LTD.
12 CHARTERHOUSE SQUARE, LONDON, E.C.1
COMPLETE LABORATORY FURNISHERS

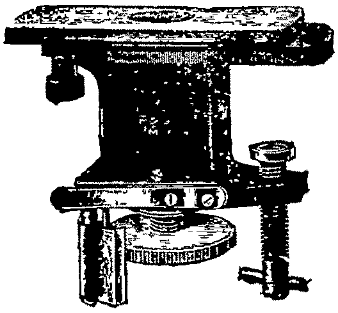
SINGER MICROMANIPULATORS
(patent application 11559/43 Foreign patents pending)

As described by Barer and Saunders-Singer, Q J M S , Vol 89, pp 439-74, Dec 1948



SINGER INSTRUMENT COMPANY LIMITED
Fountain Court, 83 London Street, Reading, Berks, England
Manufacturers also of the Singer Microdissectors

MICROSCOPES and ACCESSORIES



BENCH MICROTOME

As used in our own laboratories for many years

For sectioning plant stems, roots, leaves, celloidinised material, etc , simple but efficient

Price without knife **£6**

Illustrated leaflet on application

Part of our comprehensive service to Biologists

FLATTERS & GARNETT LTD.
309 Oxford Road, Manchester 13
Over 50 Years' Service to Microscopy

Specific Gravity Fluids

A leaflet will give details of the heavy liquids stocked for flotation tests

They are available as plain substances which you mix as required, or in sets of mixtures at quite small subdivisions of density

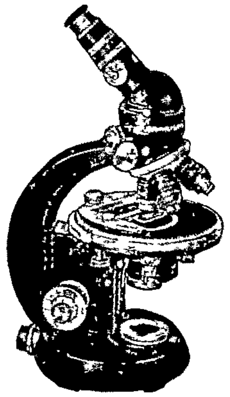
Please ask us to send a copy

RAYNER
100 NEW BOND STREET, LONDON, W 1
Telephone GRO 5081

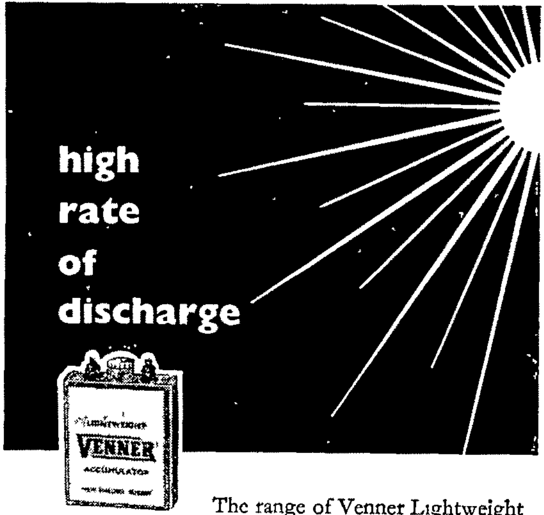
ZEISS
WINKEL

Polarising Microscope

The refinements of the Winkel Standard design, the built-in illumination, the precision and safety device of the objectives are made available for users of polarising microscopes A full range of accessories is available



Full details from
DEGENHARDT & CO., LTD
32 MADDOX STREET, LONDON, W 1
Telephone MAYfair 6639
SOLE IMPORTERS FOR GT BRITAIN & N IRELAND



The range of Venner Lightweight Silver-Zinc Accumulators has an exceedingly high rate of discharge with very little drop in effective capacity Wherever excess weight and size are serious disadvantages in electrical storage, the Silver-Zinc Accumulator is indispensable

Write for full technical details and catalogue N

VENNER ACCUMULATORS Ltd
Kingston-By-Pass, New Malden, Surrey
Phone: MALden 2442
Associated Companies. Venner Limited—Venner Electronics Ltd

VENNER
ACCUMULATORS

Official repairing agents in Great Britain for Carl Zeiss of Jena and Bausch & Lamb, U S A

C&P

REPAIRS to ANY MAKE of
MICROSCOPE : MICROTOME
MICROPHOTOGRAPHIC APPARATUS
METALLOGRAPHIC APPARATUS, ETC.

Special apparatus made to customers' designs or instructions

B. COOK & S. PERKINS
Pembroke Works, Pembroke Rd., Muswell Hill,
London, N.10 *Telephone* TUDor 9731-2-3

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE
FROM LIVER OR YEAST

and other SIGMA brand products are now available
Ask for list SIGMA 8

GEORGE T. GURR LTD.
136-138 NEW KINGS RD, LONDON, S W 6
The Microscopical Stain People

• **Individually Tested and Guaranteed** •
(A E R E Harwell approved)

HIGH VACUUM STOPCOCKS

New Catalogue on request to

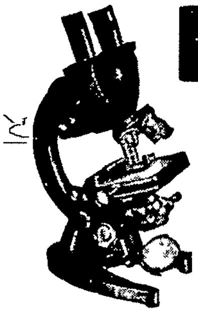
G. SPRINGHAM & CO. Harlow New Town
"The Stopcock People" HARLOW 24108

NYGON
SEAL MATERIAL
(High vacuum equipment)

Nygon seal material is specially prepared for high vacuum sealing It is made in 'O' Rings and sheet form, is black in colour with a highly polished surface and has a shore hardness of approximately 50°.

Send your enquiries to

N G N ELECTRICAL LIMITED
NASSAU MILL PATRICROFT MANCHESTER
TELEPHONE ECCLES 1643



Microscope Bargains

Secondhand Bargains Watson "Service," 2 objectives, £28 10s , Spencer, Laboratory, 3 objectives, £42 10s , C T & S Medical, 2 objectives, £22 10s , Watson "Kima," 2 objectives, £22 10s , Baker, Laboratory, £52 10s , Beck 47C (2a), £45 10s , Swift, Botanical, 2 objectives, £8 10s , Beck Medical, 3 objectives, £32 10s , Beck Laboratory, £48 10s., Zeiss, 3 eyepieces, 3 objectives, £33 10s

[illegible]

WALLACE HEATON LTD

127 NEW BOND STREET, LONDON, W 1 MAYFAIR 7511

MANSFIELD OIL-GAS PLANT FOR LABORATORIES' GAS SUPPLY

● *Reliable* ● *Simple to Operate* ● *Safe*

Provides a gas supply at a constant calorific value of 1,350 B.T.U.'s per cu ft. produced from Light Diesel Oil, Gas Oil, Paraffin, or other suitable oils available at low cost.

Enables the efficient use of a full range of modern gas burning appliances in any part of the world. Ideal for glass blowing and gives perfect oxidising or reducing flames with ordinary atmospheric burners.

For full particulars send details of estimated number of burners to be used.

MANSFIELD & SONS LTD.

62 HAMILTON SQUARE, BIRKENHEAD

Greenings

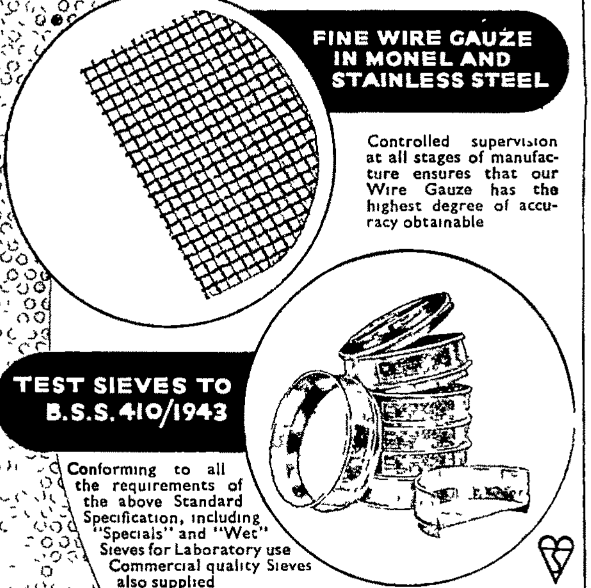
N GREENING & SONS LTD

BRITANNIA WORKS

WARRINGTON · ENGLAND

P.O Box 22

FINE WIRE GAUZE IN MONEL AND STAINLESS STEEL



Controlled supervision at all stages of manufacture ensures that our Wire Gauze has the highest degree of accuracy obtainable

TEST SIEVES TO B.S.S. 410/1943

Conforming to all the requirements of the above Standard Specification, including "Specials" and "Wet" Sieves for Laboratory use

Commercial quality Sieves also supplied

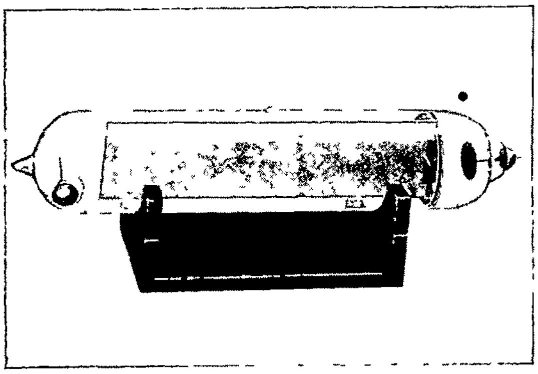
COMPREHENSIVE STOCKS ALWAYS AVAILABLE AT WARRINGTON & HAYES

N G 13

DEMONSTRATION VACUUM TUBES

for

SCHOOLS, COLLEGES, ETC.



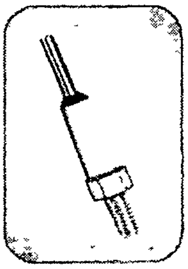
SOLUS ELECTRONIC TUBES LTD.

15/18 Clipstone Street

Gt. Portland Street, London, W 1

Excellence in design...

Specialists in sub-miniature Telecommunication Components



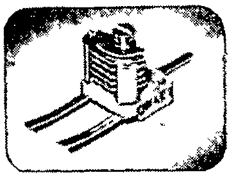
STAND OFF INSULATOR

For 1,500 volt working
Overall height 1 1 in
Over chassis 86 in
Dipped tinned spill 35 in
Thread and hexagon 6BA

These are reproduced (approx) actual size

MINITRIMMER

Standard maximum capacities up to 13 pF Voltage 500 DC Base $\frac{3}{8}$ in square with fixing centres for 10 BA $\frac{1}{4}$ in apart



Details from —

OXLEY

DEVELOPMENTS CO. LTD.

ULVERSTON NORTH LANCS *Tel:* Ulverston 3306

BECK

APOCHROMATIC OBJECT GLASSES

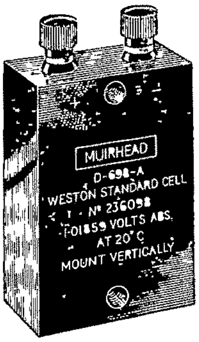
The Beck series of Apochromatic Microscope Object Glasses, which have set the highest standard of performance, are now again available for quick delivery.

No.	English designation Inches	Focal length m/m	Numerical aperture	£	s	d
3240	1½	40	·11	10	17	6
3241	⅔	16	35	13	5	0
3242	⅓	8	65	18	5	0
3244	⅙	4	95	20	12	6
‡3245	⅙	4	95	23	0	0
*†3247	⅛	3	1 2	26	7	6
*3248	1/12	2	1 3	33	15	0

* Oil immersion
† Including stop to reduce aperture to 95 N A
‡ Provided with correction collar for using cover glasses of different thicknesses

R. & J. BECK LTD.

69/71 MORTIMER STREET, LONDON, W 1



A New Standard Cell by MUIRHEAD

£3.0.0

(Post free in U K)

D-698 WESTON STANDARD CELL

This new cell combines the robustness and small size of our D-550 Miniature Standard Cell with a high capacity previously only obtainable in larger and more expensive types such as our D-402

Whether you require a standard of E M F for an industrial application or for laboratory use, this new cell will meet your needs and give many years of reliable service

SPECIFICATION

E M F	1 01859V+110μV −90μV at 20°C
Temperature coefficient	− 0 00004 per °C
Discharge rate	Up to 20μA for short periods
Internal resistance	600 ohms
Overall dimensions	1 15/16″ x 1″ x 3 3/8
Weight	4 oz

Our D-550-A and D-402 Weston Standard Cells are still available

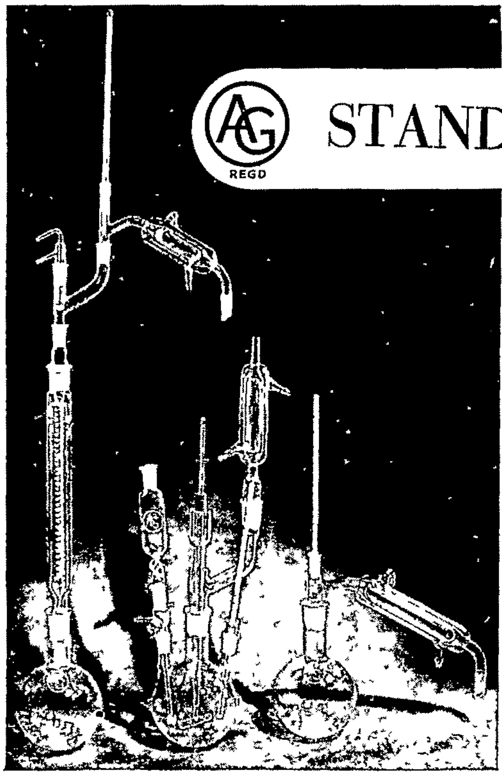
WRITE UNDER YOUR BUSINESS LETTERHEAD FOR PUBLICATION 5716

MUIRHEAD & CO. LIMITED BECKENHAM KENT ENGLAND
PRECISION ELECTRICAL INSTRUMENTS 147

Equip your laboratory with

AG STANDARD JOINT GLASSWARE

REGD



The present series offers . . .

MAXIMUM VERSATILITY
EFFICIENCY
ECONOMY

MINIMUM USE OF ADAPTERS
NUMBER OF JOINT SIZES

+ STRATEGIC USE OF SPHERICAL JOINTS

A. GALLENKAMP & CO., LTD.

17-29, SUN STREET, LONDON, E.C 2

Printed in Great Britain by Fisher, Knight & Co , Ltd , The Gainsborough Press, St Albans, and published by Macmillan & Co , Limited, at St Martin's Street, London, W C 2, and St Martin's Press, Inc , 103 Park Avenue, New York 17, N Y , U S A —Saturday, January 22, 1955

"NATURE", JANUARY 29, 1955
SUPPLEMENT· RECENT SCIENTIFIC AND TECHNICAL BOOKS

NATURE

*'To the solid ground
Of nature trusts the Mind that builds for aye'*—Wordsworth

INSTITUTE OF RADIO PHYSICS AND ELECTRONICS
LIBRARY
Date

VOL 175, No 4448 SATURDAY, JANUARY 29, 1955 TWO SHILLINGS

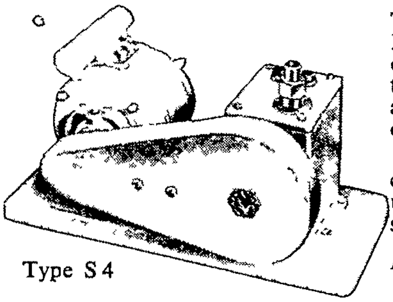
THE Newton

LONG WORKING DISTANCE ATTACHMENT

provides a working distance of 12 8 mm between object glass and specimen when fitted to a standard microscope in conjunction with a conventional 4 or 8 mm objective.

A further important feature is that the use of this attachment eliminates image reversal and thus further facilitates examination and manipulation of specimens.

Write for further details to Metropolitan-Vickers Electrical Co, Ltd, Trafford Park, Manchester, 17
Member of the A E I Group of Companies N/A 101



METROVAC PUMPS

Type S 4

Typical of the Metrovac range of rotary pumps, the Type S 4 has a displacement of 0 4 litres/sec.

Other models cover the range up to 33 litres/sec.

Please write for full details.

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

Member of the A E.I. group of companies

VACUUM PUMPS

N/P402

Humidity Measurement & Control

Hair Element
Wet and Dry Bulb
Gregory Electrolytic

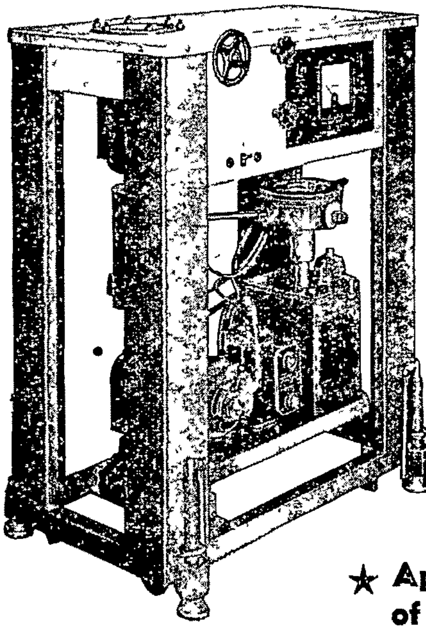
MERCURY-IN-GLASS
MERCURY-IN-STEEL
ELECTRICAL RESISTANCE

Methods

Send for List H/20: Post free

Negretti & Zambra, Ltd., 122 Regent St., W.1 **REGent 3406**

BRANCHES: *Birmingham · Cardiff · Glasgow · Leeds · Manchester · Nottingham*
*AGENTS OVERSEAS: Argentina · Australia · Belgium · Brazil · Canada · Czechoslovakia · Denmark
Egypt · Eire · Finland France · Greece · Holland · Iceland · India · Italy · New Zealand
N. Ireland · Norway · Portugal · S Africa · Spain · Sweden · Turkey
Technical Service available in most countries.*

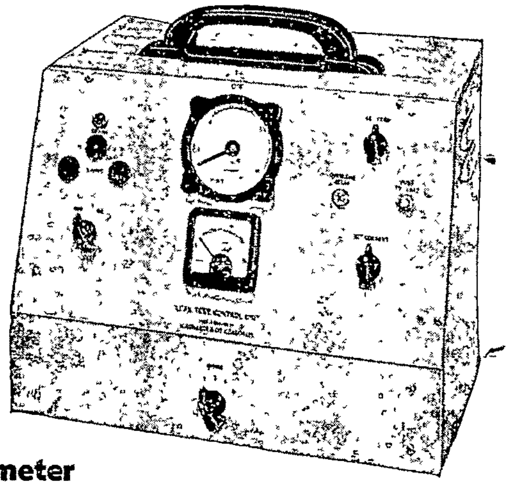


★*Critical* VACUUM LEAK TESTING applied *ECONOMICALLY*

Working with critical vacuum processes or hermetically sealed instruments, such as mercury arc rectifiers, electron tubes, etc., slow leaks can prove extremely costly Utilising a simple 'tracer-gas' technique, EDWARDS PALLADIUM - BARRIER LEAK TESTER is a highly accurate and reliable instrument with a sensitivity approaching that of the mass-spectrometer—but without its complications or expense

Best results are obtained, as with all detection systems, when used with a pumping system specially designed for leak testing **Standard leak test pumping systems are manufactured by W Edwards Send for full details**

★ **Approaching that of the Mass-Spectrometer**



W. EDWARDS & CO (LONDON) LTD *for better vacuum service*

MANOR ROYAL · CRAWLEY SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

CASELLA LONDON

TEMPERATURE & HUMIDITY

— at a glance

THE IDEAL INSTRUMENT FOR USE IN
OFFICE, STORE ROOM OR FACTORY

This Hair Hygrometer, which enables the relative humidity to be read accurately and quickly, can be fitted with either a Fahrenheit or Centigrade Thermometer.

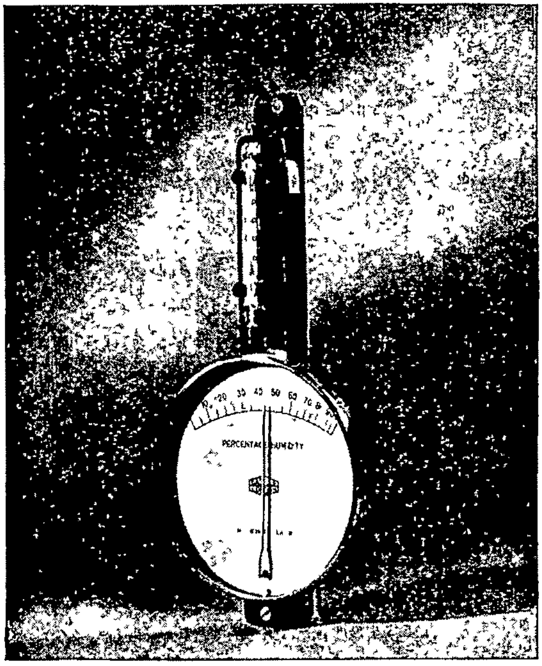
IMMEDIATE DELIVERY

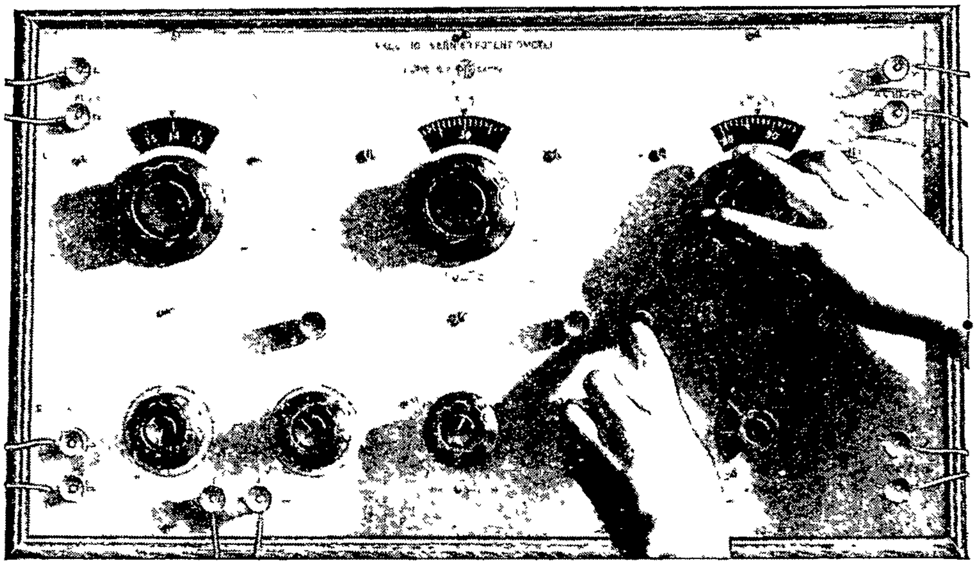
Price £4 19s. 0d.

For further details write to

C. F. CASELLA & Co. Ltd.
REGENT HOUSE FITZROY SQUARE
LONDON, W.1
Telephone ★EUSton 3944

Member Scientific Instrument Manufacturers' Association of Great Britain





Built by Craftsmen . . . . *Pye Precision Vernier Potentiometer*

ACCURACY WITHIN YOUR GRASP

Designed for measurements of a very high order of accuracy, this VERNIER potentiometer is being used extensively for the accurate measurement of resistance, as a standard for calibrating potentiometers, meters and other electrical measuring instruments, for measuring thermo-couple voltages and for many applications of a similar nature. Through every stage of its manufacture the most careful precautions are taken to eliminate possible sources of error

Please write for details of our range of precision potentiometers which also includes a SLIDE-WIRE type reading to 1 microvolt with an accuracy of 02% as well as a PORTABLE type which is completely self-contained, compact, robust and always ready for immediate use.

Our new catalogue giving details of our comprehensive range of Galvanometers, Shunts, Standard Cells and other precision measuring instruments is available on request. May we please send you a copy?

STANDARD EQUIPMENT IN MANY LEADING LABORATORIES

SCIENTIFIC PYE INSTRUMENTS

W. G PYE & CO LTD , GRANTA WORKS, CAMBRIDGE, ENGLAND.
WG 56

PRECISION BS INSTRUMENTS

Do you need to measure accurately refractive indices of both solids and liquids?

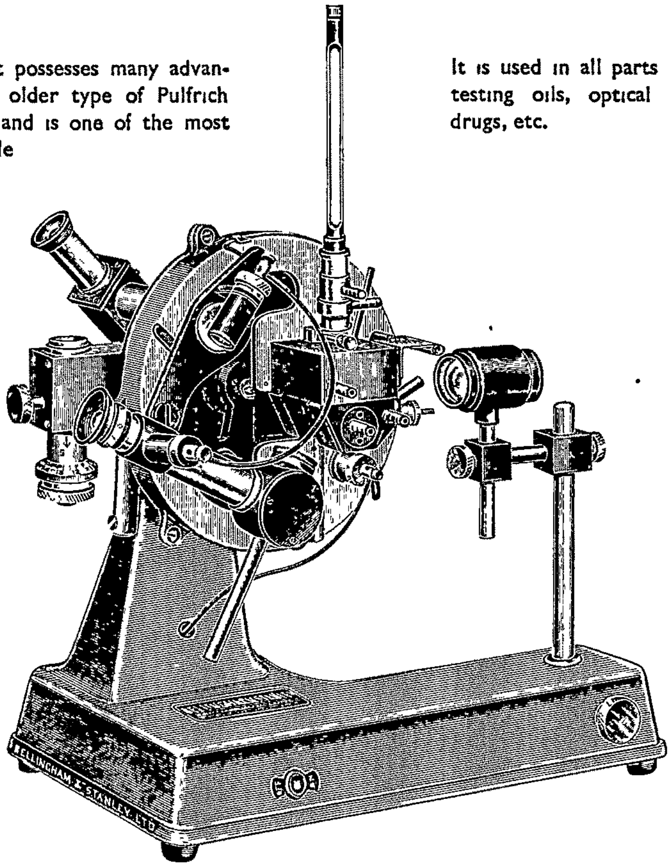
If so, send for particulars of our

Pulfrich Refractometer

fitted with a circle divided on glass and giving readings, on opposite sides of the circle, to 5 seconds by double microscope.

This instrument possesses many advantages over the older type of Pulfrich Refractometer, and is one of the most accurate available

It is used in all parts of the world for testing oils, optical glass, chemicals, drugs, etc.

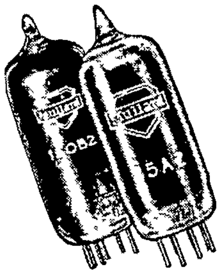


You are invited to visit our Showroom where our technical staff are always available to give help and advice as to the equipment most suited to particular problems.

Bellingham & Stanley Ltd.

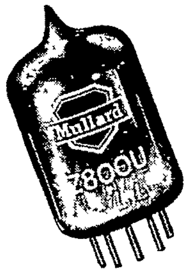
DEPT. N, 71 HORNSEY RISE, LONDON, N.19

PHONE: ARCHWAY 2270



STABILISERS & REFERENCE TUBES

Characterized by close tolerance burning voltages, very small voltage fluctuations, freedom from sudden large jumps throughout working current range, and long-term stability.

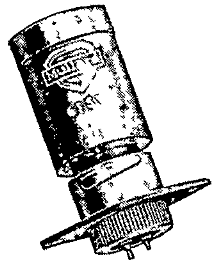


TRIGGER TUBES

Cold cathode tubes for particle counters and very low current stabilisers.

ELECTROMETERS

Triode and pentode octal and subminiature types for use with radiation monitors, photocells and other devices where a high input impedance is essential

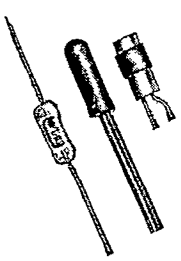


PHOTOCELLS

Vacuum- and gas-filled photoelectric, and lead sulphide photoconductive types for light-activated relays and infra-red applications

SPECIAL QUALITY VALVES

Special counterparts of popular types, designed and manufactured to withstand shock and vibration and to provide extra all-round reliability



SEMI-CONDUCTOR DIODES & TRANSISTORS

A range of germanium diodes and transistors for scaling circuits, very low power H T generation and for trigger circuits

Valves and Tubes for Nuclear Physics

Among the valves and tubes in Mullard's comprehensive range are many that are suited for the most specialised and complex applications. Whatever your interest in electronic valves and tubes, your enquiries will be welcomed at the address below where full technical details and characteristic curves are available.

Mullard

MULLARD LTD COMMUNICATIONS & INDUSTRIAL VALVE DEPT.,
CENTURY HOUSE, SHAFTESBURY AVENUE LONDON W C 2

MVT155

Wherever you need distilled water — in laboratory, factory or shop — you can use 'Deminrolit Water' with equal results. The Portable 'Deminrolit' plant operates by ion exchange and delivers water substantially free from dissolved solids. Running costs are measured in pence instead of in pounds, and you can thus use distilled quality water for many purposes where the cost of distillation would prove prohibitive. Please write for Technical Publication No. 62 which gives full details.

HIRE SERVICE

Why not try demineralised water in your industry? You can do so easily and cheaply by hiring from us, at a nominal rental for a trial period, the latest Mark II Model Portable 'Deminrolit' Plant. Details of this service will gladly be supplied on request.

PERMUTIT 'DEMINROLIT'

THE PERMUTIT COMPANY LIMITED
(Dept. V.H. 173), Permutit House, Gunnersbury Avenue, London, W.4. *Telephone: CHIswick 6431*

a New STABILISED POWER SUPPLY UNIT FOR PHOTO-MULTIPLIERS

Ediswan now have available a new stabilised power supply unit which has been specially designed to feed Photo-Multipliers. It is particularly suitable as a supply unit for Ediswan Mazda Photo-Multipliers type 27 M1, 27 M2 and 27 M3

BRIEF SPECIFICATION				
INPUT	OUTPUT	STABILITY	OUTPUT RESISTANCE	RIPPLE
200–250 v, 40–100 c p s	High stability low ripple D C supply variable between 300 and 1,100 volts Max current 2 mA Pos or neg may be earthed	A 10% change in mains input voltage results in a change of less than 0·1% between 1,100 volts and 600 volts output	Approximately 1,500 ohms	Less than 0·01% R M S
MOUNTING The Unit is suitable for standard rack mounting or for bench use Bench Stands are available				

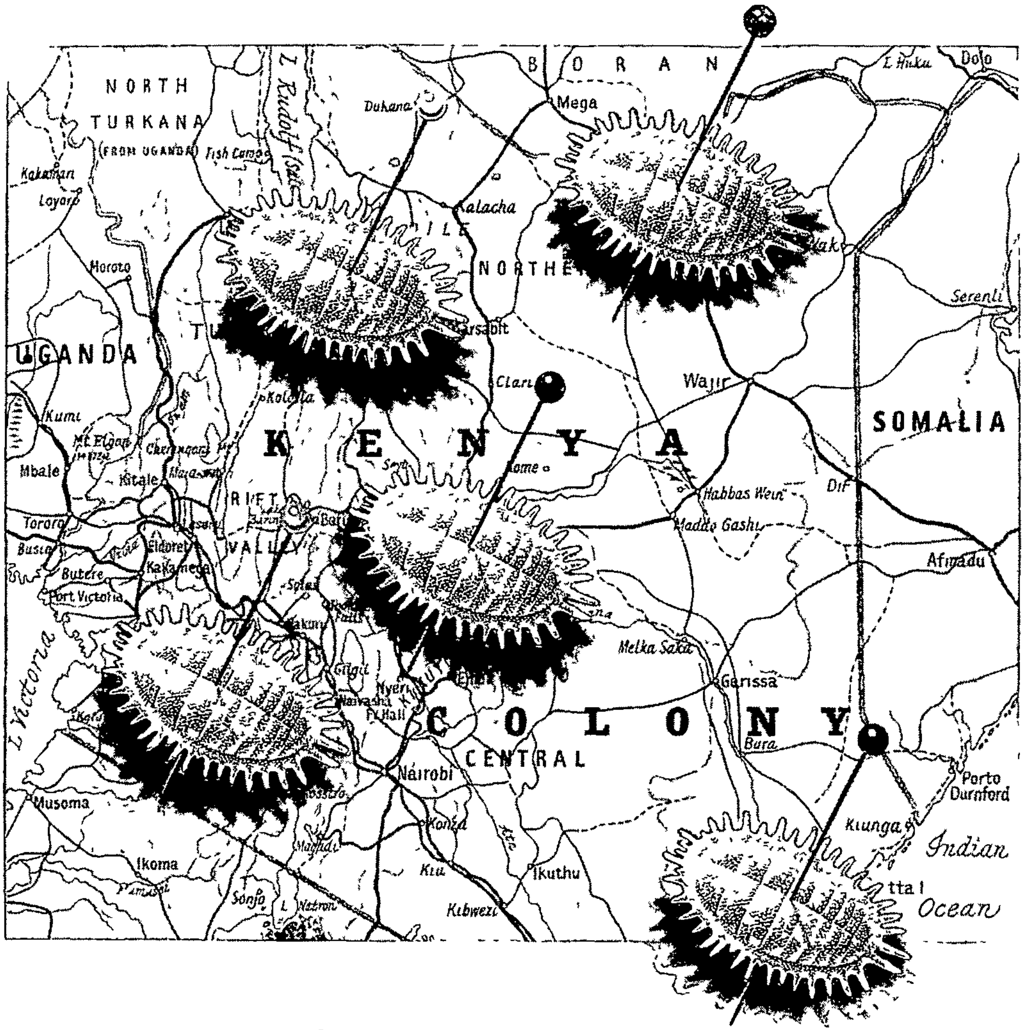
PRICE — £48

Further information is available on request

EDISWAN

RADIO DIVISION · THE EDISON SWAN ELECTRIC COMPANY LIMITED
155 Charing Cross Road, London, W C 2 *Telephone* Gerrard 8660 *Telegrams* Ediswan, Westcent, London
Member of the A E I Group of Companies

SP115



The case of *Pseudococcus kenyae* . . .

P. kenyae is a mealy bug which feeds on the sap of Kenya's coffee trees and spreads disease through the plantations. Given the chance, predatory insects soon clean up infestations — but between the mealy bug and the predators stands a species of ant. In return for a secretion of 'honeydew' the ants protect the mealy bugs from their natural enemies.

Direct control of the pest has always been difficult, because mealy bugs wear waxen coats which throw off insecticides. However, Kenya coffee growers have solved the problem by using the Shell insecticide dieldrin — against the ants.

Dieldrin is a powerful and persistent ant destroyer. One low-cost application to the stems of the trees acts as a lethal barrier to the ants for at least two months, by which time the predators have moved in and killed the mealy bugs.

Dieldrin is one of the newer Shell insecticides, effective against a very wide range of crop-destroying pests. Its exceptional persistence, surer kill and lower dosages are now aiding agricultural production throughout the world. It is also extensively used as a residual spray against disease carrying insects.

Aldrin — another recent Shell development — is fast becoming recognised as the best of all insecticides for the control of pests in the soil.

Is there an urgent pest problem in your area?

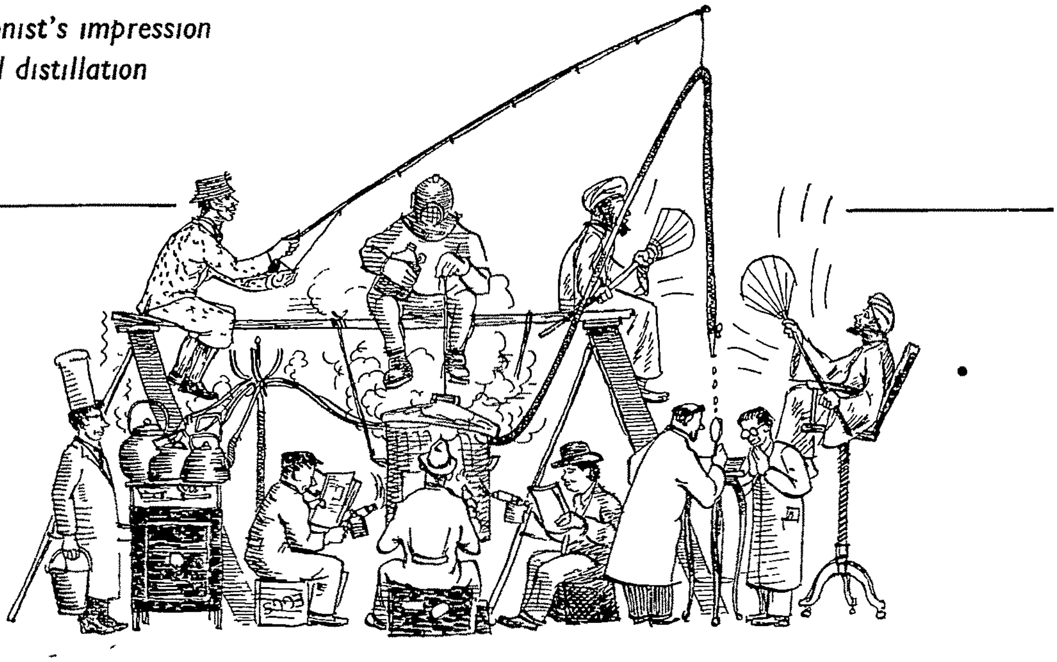
dieldrin

dieldrin and aldrin are SHELL insecticides for world-wide use

For further information apply to your Shell Company

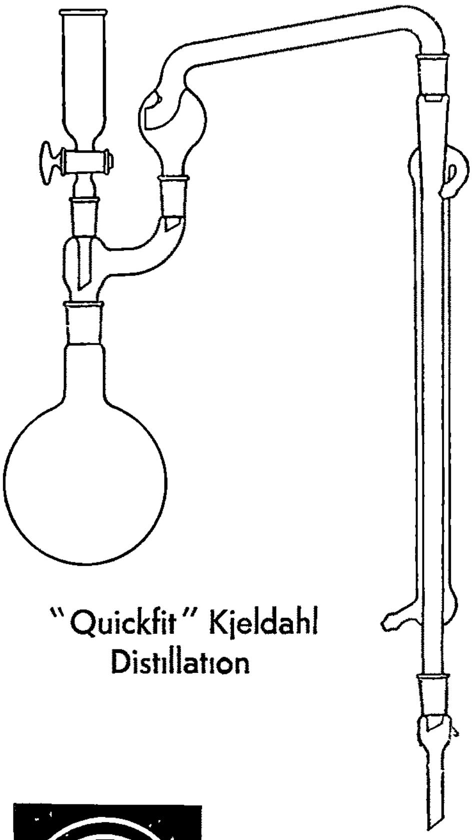
Issued by The Shell Petroleum Company Limited London, E.C.3 England

Our cartoonist's impression of Kjeldahl distillation



The quicker way is the
"QUICKFIT" way!

Here is an all-glass assembly for Kjeldahl distillation The ground joints fitted to each part eliminate the problem of the decomposition of the bungs otherwise used Easier handling and more accurate results are two more important advantages.



"Quickfit" Kjeldahl Distillation

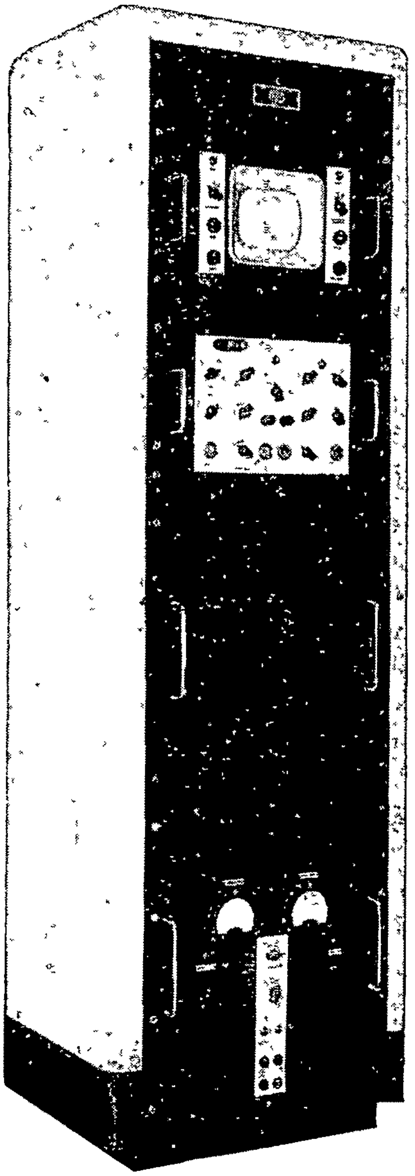
QUICKFIT & QUARTZ Ltd

INTERCHANGEABLE LABORATORY GLASSWARE

Dept. Z.Y., "Quickfit" Works,
Heart of STONE, Staffs.
Telephone: Stone 481

PROGRESS IN CONTROL

**SUNVIC
PULSE HEIGHT
ANALYSER**



An instrument for the analysis of a complex pulse amplitude spectrum into groups of known height according to their voltage amplitude.

It displays up to a maximum of 120 channels and can store 1,200 binary digits The design is based on that of Hutchinson & Scarrott (*Phil Mag.*, 42, 792, 1951) and the instrument is made under licence from the N R.D C.

EQUIPMENT BY SUNVIC

SUNVIC CONTROLS LTD *(Special Products Division)*, *No 1 Factory, Eastern Industrial Estate, Harlow, Essex* Telephone Harlow 24231/5
Manufacturers of Pneumatic and Electrical Instruments for detection, measurement, control and recording of Temperature, Flow, Liquid Level, Specific Gravity and Pressure, in Science and Industry Vacuum Pumping and Measuring Equipment, etc
Member of the A.E I. Group of Companies.

TAS/Sc 305

CASEIN

LOW VITAMIN CONTENT

In the field of research on animal nutrition a Casein of low vitamin content is required as a vitamin-free animal protein base. *Casein — low vitamin content* — as supplied by Whiffens, has a protein content of not less than 90% The process by which it is made is designed to remove both fat and water soluble vitamins, making the product suitable for the usual biological depletion procedures. It conforms to the following general specification:—

Appearance	**Cream coloured powder**
Loss at 100°C	**Not more than 5%**
Protein (by Nitrogen)	**Not less than 90%**
Ash	**Not greater than 2.0%**
Aneurine Hydrochloride	**Not greater than 1 pt. per million**
Riboflavin	**Not greater than 0.25 pt. per million**
Nicotinic Acid	**Not greater than 1 pt. per million**
Pantothenic Acid	**Not greater than 0.75 pt. per million**

Analyses of individual batches are available on application
Available in units of 3 Kgs packed in hermetically sealed tins

Each consignment of CASEIN-LOW VITAMIN CONTENT
is identified by a batch number.

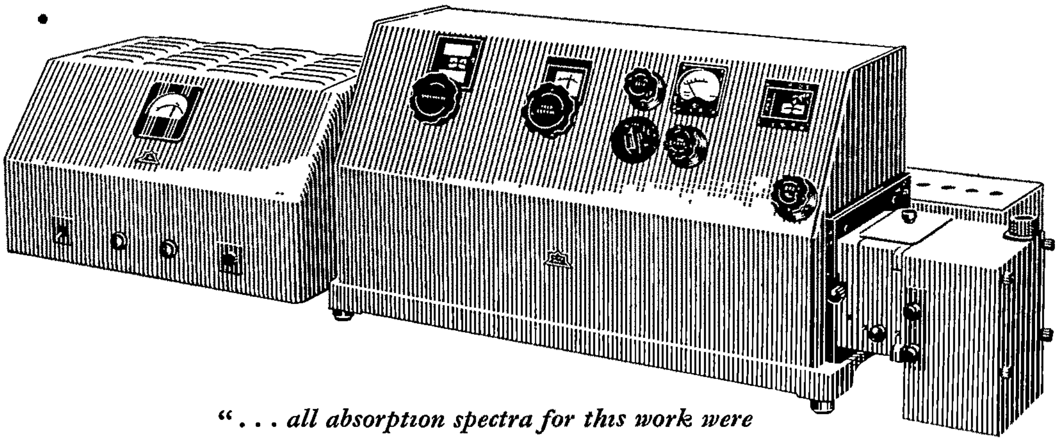
WHIFFENS

fine chemicals for industry

WHIFFEN & SONS LTD. NORTH WEST HOUSE, MARYLEBONE ROAD, LONDON, N W 1 TELEPHONE PADDINGTON 1041/9
TELEGRAMS WHIFFEN, NORWEST, LONDON

RELIABLE IN ALL WORKING CONDITIONS

"... the most convenient method was found to be ultraviolet absorption measurement ..."



"... all absorption spectra for this work were measured with a Unicam Quartz Spectrophotometer model SP 500 .. "

The frequency with which the Unicam SP.500 is mentioned in the literature is convincing proof of the sustained quality of its performance and of the wide variety of applications for which it is particularly suitable. For the maintenance of standards of both raw materials and the final product, for academic and medical research, wherever there is a problem of analysis or control, the easiest, most efficient, most economical answer may well be the Unicam SP.500 Spectrophotometer.

An illustrated leaflet describing the instrument in detail will gladly be sent on request.

UNICAM

UNICAM INSTRUMENTS LTD · ARBURY WORKS CAMBRIDGE

U124

NATURE

No 4448 SATURDAY, JANUARY 29, 1955 Vol. 175

CONTENTS

Page
University Education in Central Africa 181

Medical Bibliography and its Problems By Dr E Ashworth Underwood 182
A Technological Approach to the Study of Bacterial Morphology By Dr K A Bisset 184
Colour Photography By Prof W D Wright 184
Presenting Modern Chemistry By G Fowles 185

The University of Malaya By Sir Sydney Caine, K C M G 186
Recent Trends of Glacier Fluctuations in the North Atlantic Area By Dr. M M Sweeting 188
British Cotton Industry Research Association Annual General Meeting 190

Obituaries .

Sir Arthur Keith, F.R S. By Sir Wilfrid Le Gros Clark, F.R.S. 192
Mr J E Sears, C B E By Dr H Barrell 193

News and Views . 193

Survey of Field Theory Autumn Meeting of the Physical Society By Prof R W Ditchburn 197
The Geographical Association By Prof W G V Balchin . . . 198
Science Masters' Association Annual Meeting at Newcastle upon Tyne By W H Dowland 199
The British Flora during 1954 By J E Lousley . 200
Hydraulic Transport of Coal By Prof H Heywood . 202
Recent Work in Mayan Archæology By Dr G H S Bushnell 202
Effect of Streptomycin on Various Enzymes responsible for Syntheses and Degradations of Higher Saccharides By Dr S A Barker, Dr E J Bourne, Prof M Stacey, F R S , and R B Ward . 203
Exchange Reactions in the Entry of Cations into Plant Tissues. By R Scott Russell and M J Ayland . 204

Letters to the Editors

Analgesic and Antipyretic Activities of 4-Hydroxy*iso*phthalic Acid —G B Chesher, H O J Collier, F A Robinson, E P Taylor, S E Hunt, J Idris Jones and A S Lindsey 206
Imidazole Complexes of Myoglobin and the Position of the Hæm Group —J C Kendrew and R G Parrish 206
Acetylation of Sulphanilamide in Plants —Dr D Rudd Jones and Jenifer Wignall 207
Rat Liver Xanthine Oxidase in Carbon Tetrachloride Poisoning —Dr Gilberto G Villela and Emilio Mitidieri 208
Infectivity and Nucleic Acid Content of Influenza Virus —G L Ada and Beverley T Perry . 209
Total Sugar and Nitrogen Contents of Jute Plants, with Special Reference to the Flowering Stage —Miss Sumitra Talukdar 210
Cortical Zonation and Survival of Chromaffin Cells in Adrenal Autografts —Rex E Coupland 211
A Substance from Eel Serum producing Slow Contractions —Dr R Jaques 212
Spontaneous Microscopic Activity in Cardiac Muscle —K Hellmann 212
Phenolic Substances of Pear–Apple Hybrids —A H Williams 213
Growth of *Chondromyces crocatus* in Pure Culture —C W Hesseltine and Dorothy I Fennell 213
Shape of Bacterial Flagella —Prof Adrianus Pijper 214
Use of Snail Stomach Cytase in Plant Cytology —T C Chambers 215
Selective Fertilization following the Use of Sperm Mixtures in the Mouse —R G Edwards 215
Role of the Nuclei of the Follicle Cells in the Formation of the Chorion in *Cimex lectularius columbarius* Jen — B Dasgupta and H N Ray . 216
Rearing Experiments on Marine Teleost Larvæ and Evidence of their Need for Sleep —S Z Qasim 217
Population Regulation in Rabbit Nematodes —P C Bull 218
Absorption Spectrum of Deeply Coloured *Cyclo*pentadiene Polymers —C F Blakely and Dr A Wassermann . 219
Mechanism of Osazone Formation —Dr Vincent C Barry and P W D Mitchell 220

Recent Scientific and Technical Books Supp vi

CHAPMAN & HALL

Just Published

INTRODUCTION TO ATOMIC AND NUCLEAR PHYSICS

by

Henry Semat, PH D

Third Edition, Revised and Enlarged

9" × 5¾" 576 *pages* *Illustrated* 50*s net*

FUNDAMENTALS OF TRANSISTORS

by

L. M. Krugman, B S , M S , P E

(U S Signal Corps Laboratories)

8½" × 5½" 140 *pages* 110 *figures* 21*s net*

THE TECHNOLOGY OF SOLVENTS AND PLASTICIZERS

by

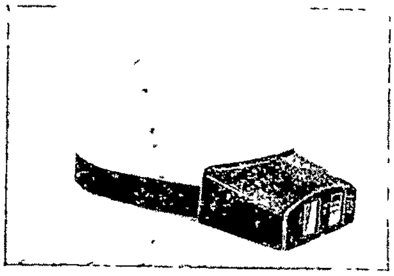
Arthur K. Doolittle

(Assistant Director of Research, Carbide & Carbon Chemicals Co , U S A)

9½" × 6" 1056 *pages* 463 *figures* 130 *tables* 148*s net*

37 ESSEX STREET, LONDON, W C 2

MAGNIFIERS



The headband magnifier which is illustrated is one of the 200 different types described in our free booklet, " Magnifiers and Visual Aids " Hand reading glasses, watchmakers' eyeglasses, triple achromatic loupes, illuminated stand magnifiers, telescopic spectacles all are included

Please ask us to send a copy

RAYNER

100 NEW BOND STREET, LONDON, W 1

Telephone GRO 5081

Second-hand Books

ON

PURE AND APPLIED SCIENCE

STANDARD WORKS : SETS OF SCIENTIFIC JOURNALS, OLD AND RARE SCIENTIFIC BOOKS

LARGE OR SMALL COLLECTIONS BOUGHT

H. K. LEWIS & Co. Ltd.

LONDON 136, GOWER STREET, W C.1

Telephone EUSton 4282 (7 lines) Established 1844

The SCIENTIFIC BOOK SUPPLY SERVICE

(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

UNIVERSITY EDUCATION IN CENTRAL AFRICA

TEN years ago, the University of London accepted a special responsibility concerning the development of higher education in the Colonial territories of the British Commonwealth The aim of the University's action was the fostering of ultimately independent and autonomous Colonial universities, and for this purpose there was formed in 1944 a Committee of the Senate for Higher Education in the Colonies This Committee—not to be confused with the Inter-University Council for Higher Education in the Colonies—had the task, among others, of considering the applications of Colonial university colleges for acceptance into what came to be known as 'special relationship' with the University of London. The latest applicant for entry into special relationship has been the new multi-racial Rhodesia University College, the origins of which have previously been discussed (*Nature*, 172, 1 , 1953 , 173, 1007 , 1954)

In its special relationship with such institutions, the University of London has an interest in almost every aspect of their development, especially in the academic standing of the staff, in the appointment of which it plays an active part. Another important matter is the level which a candidate must reach in order to gain entry to the college The degrees granted are those of the University of London, and the final decision on syllabuses and examinations rests with that University for so long as the special relationship exists In some Colonial territories the secondary school system is not sufficiently developed to enable candidates from school to attain the normal standard of entry to the University of London. Since the ultimate standard attained is fixed—that of a bachelor's degree of the University of London—the ordinary course of study in the relevant university college is, in such instances, longer than that laid down by the general regulations of the University of London

The inaugural board of the Rhodesia University College has recently decided to ask the University of London to make no special concession with regard to the entrance requirements for its College. In the Federation of Central Africa, the Cambridge Oversea School and Higher Certificate examinations are taken in the secondary schools. For admission to the University of London a candidate normally needs to possess a General Certificate of Education with passes in prescribed subjects, of which at least two must be at the Advanced level, but passes in principal subjects of the Cambridge Oversea Higher School Certificate are accepted as equivalent to passes in the General Certificate at Advanced level. The University also accepts credit passes in subjects of the Cambridge Oversea School Certificate as equivalent to ordinary passes in the General Certificate examination. The high level of entrance standard demanded by the Rhodesia University College will keep the number of non-European entrants to a small proportion of the total when the College opens in 1956 But one may hope that with an adequate intake of European students, competition for entry will lead to a rapid expansion in the number of African secondary schools in the Central African Territories which include sixth forms, and a rise in the size of the sixth forms in those schools which already teach at sixth-form level The muster of teachers suitably equipped to partake in such an expansion may well become a limiting factor, and the availability of school-teachers will itself depend in part upon the flow of graduates from the Rhodesia University College The conditions to be expected at first are therefore unlikely to lead to the immediate appearance of a large number of non-European graduates in Central Africa Nevertheless, the importance can scarcely be overrated of the new multi-racial College as a contribution to the higher education of the African at a most significant period in the history of the continent. Those who complete the full course will have reached a high and internationally recognized standard of university education, and the number of Africans who graduate each year will certainly rise early in the College's existence.

According to present plans, the Rhodesia University College will open in 1956 with Faculties of Arts and Science, and a Faculty of Agriculture also may be among the first to be instituted. The Faculty of Arts is expected to include, from the beginning, departments of English, modern languages, Latin, history, economics, African studies, and education. The Faculty of Science will cover mathematics, physics, chemistry, zoology, botany and geography Later will follow Faculties of Law and Medicine, and still later Engineering, Architecture, Music and Fine Arts In due course, special relationship with the University of London will cease, and Rhodesia University College will thereupon become a university granting its own degrees.

The financing of a new university is difficult enough in any country , but in a Federation the European inhabitants of which do not exceed a quarter of a million, it is indeed a problem. Of the £2,000,000 which will, according to estimates, be required for capital expenditure during the early years of the University College's existence, £1,250,000 has been promised from the Colonial Development and Welfare Fund and about £300,000 subscribed in the Federated Territories The recurrent costs are expected to reach not less than £250,000 per annum by 1961, and however generous the endowments may then prove to have been, a significant proportion of the current income will clearly have to be provided by the Federal Government. The growing dependence of universities upon government support is an inescapable condition of the development of higher education at the present time

In a country where racial tension can arise, the position of a multi-racial university is especially important Some of the difficulties to be faced in such a university are indicated elsewhere in this issue (p 186) in an article by the Vice-Chancellor of the University of Malaya, an institution which had the advantage of building on two established colleges. The declared aim of the Central African Federation is a partnership between the races, European and non-European, and to the attainment of this ideal a university, with the goodwill of the people and the support of the government, can make a tremendous contribution. The working out of partnership in all its details must depend vitally upon the co-operation of educated people of all kinds The Moffat Resolutions adopted by the Legislative Council of Northern Rhodesia on July 29, 1954 (*The Times*, August 14, 1954), began the task of defining partnership in a more precise way than has hitherto been attempted "(1) The objective of policy in Northern Rhodesia must be to remove from each race the fear that the other might dominate for its own racial benefit and to move forward from the present system of racial representation in the territorial legislature towards a franchise with no separate representation for the races (2) Until that objective can be fully achieved a period of transition will remain during which special arrangements in the Legislative and Executive Councils must continue to be made so as to ensure that no race can use either the preponderance of its numbers or its more advanced stage of development to dominate the other for its own racial benefit (3) During this period of transition, special legislation must be in force to protect, to the extent that may be necessary, the interests of either race Meanwhile this Council notes and agrees with the statement of the Secretary of State that it is the duty of Her Majesty's Government to ensure that on contentious issues the balance is fairly held (4) Every lawful inhabitant of Northern Rhodesia has the right to progress according to his character, qualifications, training, ability and industry, without distinction of race, colour, or creed". The significance of education, and particularly the education of the African, in the working out of such a plan must be clear to all.

The inaugural board of the Rhodesia University College has expressed its deep appreciation of the great educational services rendered by the universities of South Africa to the territories of the Central African Federation over a long period of years It has also recorded its pleasure at the many messages of goodwill received from South African universities when the foundation stone of the Rhodesia University College was laid by the Queen Mother in July 1953 The inaugural board believes that these tokens of goodwill are a sign of the interest and support of the universities of South Africa which the new College will retain in the future. Universities in Great Britain also will wish to support in their several ways a university institution of such outstanding significance to the future of the British Commonwealth.

MEDICAL BIBLIOGRAPHY AND ITS PROBLEMS

The Development of Medical Bibliography
By Dr Estelle Brodman Pp ix+226+3 plates. (Publication No. 1.) (Baltimore Medical Library Association, 1954.) 5 dollars.

THE problems of medical bibliography are cognate with those of scientific bibliography in general, and this small book will therefore be of interest to a wider circle than that for which it is primarily intended. The task of the medical bibliographer may be adequately described in the author's phrase · "to cover the entire medical literature, in whatever form, wherever published, and in whatever language, and to cover it accurately, promptly, and in easily usable form". The history of this subject has been dealt with in scattered communications for different periods and subjects, but this work is the first attempt to give a comprehensive history If the generic subject 'medicine', embracing as it does several undoubted 'sciences', is accepted as a science, then there is probably no subject in the whole range of scientific literature which has been so well served by the bibliographer. The success of his efforts in the past and in the present should therefore be of great interest to all who view with misgiving, and even alarm, the enormous increase in the literary output relating to all the sciences

Miss Estelle Brodman has wisely limited her field to the subject of medicine in general, and has excluded works dealing only with its subdivisions and specialties The general medical bibliography deals with these subdivisions, though less thoroughly than the specialized bibliographies of these subjects. Further, the specialized bibliography is a comparatively late arrival in the field. The early bibliographies were all comprehensive works which invited consultation on any subject relating to the art of medicine

The earliest medical bibliographies were poor things when examined with our present critical knowledge, and such as the historian still consults to-day he tends to find time-consuming and tiring to the eye. Of those published in the sixteenth century, the first was the "De medicinae claris scriptoribus" (1506), by Symphorien Champier, and the first subject-bibliography was that of Israel Spach Champier's work was printed in black-letter after the style of a late fifteenth-century manuscript The medical bibliography of Conrad Gesner was never published In the seventeenth century the custom of listing authors under their surnames instead of under their forenames became very general, the imprint was given regularly for each edition, and the number of cross-references relating to both authors and subjects was greatly increased The bibliography of J A Vander Linden was first published in 1637, and went through two further editions during his lifetime and one (1686) after his death. It is still used by historians, but the work would be more acceptable now if both Vander Linden and G A Mercklin, his final editor, had adopted Sir Thomas Bodley's request to the first librarian of the Bodleian "I did alwaies wishe that in the setting downe of an author's title, you would place his surname first". The "Bibliotheca realis medica" (1679) of Martin Lipenius contained about twice the number of entries in Vander Linden. It was printed on a quarto page in double column and was, to our eyes, of a much more modern lay-out.

The late eighteenth and the first half of the nineteenth centuries were the age of the great bibliographies compiled by single individuals. Some of these dealt with limited periods and are not discussed by Miss Brodman. Of these may be mentioned Choulant's "Handbuch der Bucherkunde" (1841), which is still of great value. The great bibliographies of this period were undoubtedly those of Albrecht von Haller, of Ploucquet and of Callisen. Haller's bibliography of practical medicine was only one of four similar works which he compiled. It contains fifty-two thousand references to books, dissertations and also to important articles, and it frequently gives brief critical notes on the contents of the works listed. This work by Haller is not of great value to-day, but his "Bibliotheca anatomica" is still a very useful and accurate work. Wilhelm Gottfried Ploucquet was the first bibliographer who had to tackle seriously the problem which is still fundamental—the listing of the journal-article. Between 1793 and 1797 he published eight volumes of his "Initia". The work was then complete—but only to 1793. In the interval new literature had appeared so fast that it required a supplement of four volumes to cover it. Faced then with a further large accumulation of titles, Ploucquet took the bold step of deciding to reprint his twelve volumes in a more complete and convenient format, and to integrate them so as to include their contents and his last accumulation in one alphabet. In this work he had to face the fact that it was no longer possible for one individual to define the contents of all articles listed except from the information given in their titles, and he also realized that important medical observations might be found in works which were not entirely, or even primarily, of a medical character. Callisen's invaluable "Lexicon", published in thirty-three small volumes between 1830 and 1845, is more limited in scope since it deals only with literature published roughly between 1750 and 1830. Ploucquet's work was arranged by subjects, Callisen's by authors' names.

Scientific and medical bibliography now passed into the co-operative stage, the first result being the "Catalogue of Scientific Papers, 1800–1863", which was published by the Royal Society in six volumes in 1867 and the following years. Two new volumes, covering the period 1864–73, appeared fairly soon, but the four additional volumes bringing the work up to 1883 were not published until 1902. For the seventeen years 1884–1900 seven volumes were required, and it took more than ten years to publish them. While the earlier volumes are within the means of the serious historical student, the later volumes are very costly. No supplements have yet been published dealing with the literature since 1900.

An even greater co-operative undertaking is one known to all workers in the medical field, the "Index-Catalogue of the Surgeon-General's Library". There had been five small catalogues of the books in this very rapidly expanding library between 1863 and 1873, when John Shaw Billings conceived the idea of a catalogue which would be arranged by authors and by subjects and which would, in addition, list all the important articles in journals. The first volume was published in 1880 and the sixteenth and final one in 1895. By this time the accumulation of fifteen years, which was to be published in a second series under a new alphabet, had reached such proportions that it took more than twenty years to publish the necessary twenty-one volumes. By 1916, therefore, before the commencement of publication of the third series, all references relating to authors or subjects beginning with the letter *A* were complete only up to the year 1895. From the aspect of current medical and scientific work, the catalogue was generally about twenty years out of date. The third series followed, and then a fourth, which was carried to the first part of letter *M*, when publication stopped with Vol. 10. A final volume is expected soon, but that will probably be the end of this great work.

Of the 178 pages of text in her book, Miss Brodman devotes more than forty to the position at the present day—the varying fortunes of the "Index medicus" and its gradual replacement by the "Quarterly Cumulative Index Medicus", the rise of the "Current List of Medical Literature" and its merits compared with those of its older contemporary. As her work is essentially a history, it may be argued that it would have been better to have stopped at an earlier period. On the other hand, it is desirable that the ramifications of these difficult problems should be fully understood by all who have to make extensive use of medical books and journals, and this final chapter sets out the facts very impartially.

What are the facts ? Long known to all who have viewed the field in historical perspective, they are quite clearly that medical bibliography is not now, and never has been, completely comprehensive and up to date. The early bibliographies were essentially tools for the use of the compilers, and no doubt personal interests sometimes had an effect on their completeness in certain directions. But apart altogether from this factor, there was no chance of a single individual being able to trace all the works published even during a limited period. It has been estimated—admittedly by methods which cannot be very refined—that the number of medical works printed before 1501 was 966, and that between that year and 1636 the number of editions of medical works printed was about twenty-five thousand. In his bibliography, published in 1679, Lipenius lists about 40 per cent of the authors possibly represented by these works. At the end of the eighteenth century Ploucquet was finding that his new material amounted to about ten thousand references a year. Medical and scientific journals were then in their infancy. In 1800 their number was 910. By 1866 it was more than fourteen thousand, by 1901 the number was nearly sixty thousand, and by 1908 more than seventy thousand distinct journals were being published.

Dr. Claudius F. Mayer, the distinguished editor of the "Index-Catalogue", has said that the manuscript cards increase by more than a hundred and twenty thousand yearly. The fifty-seven volumes of the "Index-Catalogue" which have so far been published contain about three and a half million references. Allowing something more than sixty thousand references per volume of the "Index-Catalogue", this means that at least two volumes per year would be required to keep up with the current intake; at its best times only one volume was published per year in the past. The present situation is far from satisfactory, and it may have to be admitted that it is impossible to provide a fairly full bibliography of medicine which is always up to date and which in the same form provides easy reference over a long period. When the "Index-Catalogue" was about to expire, many sincere requests for its continuation passed from Great Britain to the United States, but other considerations prevailed. Despite its faults, the "Index-Catalogue" does provide a permanent record of most of what is worth while, and it does so in a manner which allows of easy consultation.

Miss Brodman has written a valuable little book, to which is appended a very full list of medical bibliographies since 1500. A few minor errors are unimportant; but there is one strange mistake which should be corrected at the earliest opportunity. The author describes the lay-out of a page of Haller's "Primae lineae physiologiae" which she says appeared in eight volumes. The "Primae lineae" was a very fine one-volume students' text-book which went through many editions and translations. The great eight-volume work for which this name is a *lapsus calami* was his "Elementa physiologiae corporis humani", the eight volumes of which were published between 1757 and 1766, and not in 1747 (the date of the first edition of the shorter work). Miss Brodman perhaps gives the impression that the *Philosophical Transactions of the Royal Society* was a private venture only during the time of Oldenburg. In fact, the journal was the property of the secretaries of the Royal Society until the year after the death of Sloane. Apart from a reference in the appendix, she makes no mention of Pauly's bibliography of 1874. This is not an important omission; but in view of the fact that this work has recently been reproduced in facsimile—some authorities may consider the reproduction was uncalled for—a few notes on its merits might have been useful.

E. Ashworth Underwood

A TECHNOLOGICAL APPROACH TO THE STUDY OF BACTERIAL MORPHOLOGY

La Cellula Batterica

Di Dr. Franco Scanga. Pp. xix+477. (Roma: Il Pensiero Scientifico, 1954.) 8000 lire.

THE recent very considerable advances which have been made in the study of the morphology and cytology of bacteria have been published almost exclusively in English. It is therefore something of a landmark in the history of the subject to find so well-informed a work in any other language; and it says much for the excellence of Dr. F. Scanga's handling of his material, and the clarity of his Italian style, that I was able to read an extensive passage from one of my own works, translated from English, without any feeling of unfamiliarity. This is not always true of paraphrases in the same language by other pens.

The book is in no sense a monographic study, but is rather an attempt to provide a fully documented account of recent work in this field, with an almost exclusive emphasis upon the better-known groups of bacteria. Although the effect has been to make it considerably larger, and thus presumably more expensive, than would otherwise have been necessary to convey the essential information, the language problem dictates that this is much the most valuable, and indeed the only suitable, form for the book to take. For example, Dr. Scanga neither supports nor opposes the claims of the Philadelphia group, but simply states them at length and follows with an equally full quotation from one of their more outspoken critics. The reader is left to form his own opinions.

The illustrations are numerous and well reproduced. Full use has been made of the plates which originally appeared in the Symposium on Bacterial Cytology, held in Rome in 1953, but not always with the happiest results, since many of these were originally provided by the contributors to illustrate particular points rather than general principles. It is especially unfortunate that the caption of Chapman and Hillier's now famous electron micrograph of a section of *Bacillus cereus* gives an interpretation proposed by another person on that occasion, rather than the entirely different, and much more generally acceptable, interpretation of the original authors.

As may be expected in a book of this nature, technical questions are given great prominence, and a wide selection of cytological methods is described in full, with the originators' own opinions in respect of their efficacy stated without comment—a state of affairs which may mislead intending practitioners, in some cases. Dr. Scanga's own special interest is the electron microscope, which he handles with considerable skill; and a valuable account of the techniques accompanying the use of this instrument is included. Electron micrographs accordingly provide a somewhat disproportionate preponderance of the illustrations. It might, in other circumstances, be regarded as slightly curious that the only really clear example of the now classical appearance of the bacterial nucleus, by the Robinow–Piekarski technique, is included in a page of electron micrographs, in order to establish that the much less instructive protuberances, visible upon these desiccated surfaces, actually represent the nucleus.

But these are minor blemishes in an otherwise excellent work. The author has taken the trouble to acquaint himself with the massive body of evidence which has become available, at least within the limits which he has set himself, and shows every sign of understanding it thoroughly. This is especially refreshing in a field where many who have started out with similar high intentions have retired before long behind a smoke-screen of obscurantism.

K. A. Bisset

COLOUR PHOTOGRAPHY

Principles of Colour Photography

By Ralph M. Evans, W. T. Hanson, Jr., and W. Lyle Brewer. Pp. xi+709. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 88s. net.

SOME readers of this authoritative book are likely to be disappointed unless they appreciate that it is the principles of colour photography which form its subject-matter and not colour photography itself. Only one chapter of forty-one pages out of a total of more than seven hundred is devoted to a description of the various colour photographic processes and cameras, and no colour prints are included anywhere in the book. Readers must therefore go elsewhere for a colourful presentation of the subject; but they need be under no illusion as to the ability of the authors to practise the art about which they write, for one of them, R. M. Evans, is perhaps the outstanding exponent at the present time of the artistic possibilities of colour photography.

The theory behind colour reproduction, whether by photography or television, has become quite highly developed, and the starting point is usually the laws of three-colour mixture. In terms of colorimetry, the reproduction should consist of the appropriate combination of red, green and blue radiations that will, at each point of the picture, match the colour of the original at that point This provides a working hypothesis from which to derive such items as the theoretical spectral sensitivities of the three light-sensitive processes in the colour camera For various reasons, major departures from colorimetric theory are both necessary and inevitable, and it is no easy matter to present a comprehensive and comprehensible account of all the factors that ultimately have to be considered This, however, is in essence the main intention of the book under review and the authors have made a notable and successful contribution in this field

First, we have chapters dealing with colour matching and colour measurement (those interested in the algebraic representation of these matters will be surprised to find colour equations given in a form which has been generally condemned in the United States although common practice in Great Britain until recently), followed by a discussion of the visual processes of adaptation, contrast and the like, which affect so vitally the subjective appearance of a picture yet are so baffling to express in algebraic or numerical terms Next, we have chapters on the chemistry of the photographic processes and the optical characteristics of dye mixtures and their measurement, leading naturally to colour sensitometry and the consideration of the *H* and *D* characteristics of colour processes Two chapters dealing with the special cases of duplicating and copying are interpolated, and the final two chapters discuss the generalized theories of additive and subtractive reproduction

It will be realized that this book is full of weighty material which cannot be described as light reading, yet the text itself is written in a very clear style and is therefore easy to read The authors are well aware that they have not written the final word on the subject, for their closing paragraphs and indeed the closing sentence emphasize that lack of knowledge of the visual relationship between the photograph and the scene makes it necessary for present-day processes to be worked out empirically. Yet this is an excellent statement of our present understanding of the problem, and no serious workers in colour photography or colour television can afford to ignore it if they wish to reduce the empiricism in their techniques to a minimum

W D WRIGHT

PRESENTING MODERN CHEMISTRY

General Chemistry

An Introduction to Descriptive Chemistry and Modern Chemical Theory By Prof Linus Pauling Second edition Pp xii+710+2 plates (San Francisco W H Freeman and Company, 1953) 6 dollars , 51*s*

WHEN, at a conference in the United States, Prof Linus Pauling was asked about his views on the teaching of chemistry he is reported to have said "One wants to teach that section which inspires and holds a man and which feels alive , then, moving on to greater and greater triumphs, that which both fascinates and profits mankind The text-book should contain what the writer really believes and really knows, not the stuff which seems dead and ought to be put into museums". The speech reveals the attitude to teaching in which "General Chemistry" was written and the principles which guided the writer in selecting his material and arranging its sequence "That which inspires and holds a man . .” the speaker, the grand-master in the field of the ionic bond and of the electronic structure of the molecule, showed in this work how a simple exposition of modern theoretical concepts could, to use his own words, make the presentation of general chemistry "more simple, straightforward and logical than formerly" All who have used modern theory in their teaching will concur "General Chemistry" rapidly obtained world-wide recognition as belonging to that small class of books, as did the works of W Ostwald and of Alexander Smith in days gone by, which revolutionized the teaching practice then prevailing and laid down the pattern for future texts

The first edition was reviewed and commended in *Nature* (June 26, 1948) its contents are too well known to be again listed , but those yet unacquainted with "General Chemistry" should know that it is an introduction for first-year university students In this, the second edition, Prof Pauling gives us further teaching help, for he shows us how he meets the difficult problem of giving an adequate presentation of a science, which, already huge, is expanding in every direction His plan is to increase the depth of the treatment of theory, especially of those aspects which are pertinent to the explanation of chemical behaviour and which are integrating in their incidence, so that all but the future specialist will have sufficient theory to carry him through his entire chemistry course At the same time, a new chapter entitled "Biochemistry" extends the breadth of treatment and introduces a humanizing factor For this chapter is essentially a fascinating essay on proteins, vitamins, drugs and their relation to life and mankind

Most of the additional theory is in two new chapters, respectively entitled "The Electron and the Nucleus", and "Quantum Theory and Molecular Structure". Among the topics discussed in these chapters are X-rays, the electron, radioactivity, the atomic nucleus, the quantum theory, the photoelectric effect, the photon, and the changed outlook brought about by quantum mechanics

The new introductory chapter on metals is not only interesting and inspiring but also illustrates the author's ability to use the electronic theory to explain and systematize the phenomena under discussion Thus he shows how the increase in the structural strength of successive metals in a Mendeléeff period is dependent upon the electronic configuration of the metal and of the arrangement of its atoms in the crystal Physical properties are therefore no longer seen as haphazard phenomena but, as with chemical properties, are determined by structure, and are predictable

The four new chapters, and the revision and frequent extensions of most of the original chapters, enlarge the book by 115 pages The flashes of understanding which must come from a study of "General Chemistry" and the freshness of approach to the subject-matter make it an excellent text for first-year university students or for candidates for university scholarships If not used as a text-book, a copy should be in every chemical library.

G. FOWLES

THE UNIVERSITY OF MALAYA

By SIR SYDNEY CAINE, K.C.M G.

Vice-Chancellor

THE University of Malaya is now five years old What are its achievements, its opportunities and its problems ? Created by the amalgamation of two Singapore institutions, the King Edward VII College of Medicine and Raffles College (covering arts and science), its first tasks were to merge these two units and secure recognition of their standards , to extend the range of teaching , to get assured finance for maintenance and growth , and to create an adequate physical centre for itself

During all its early years the University has been troubled—some would say bedevilled—by the last problem, of siting. It had been agreed by the Governments of Singapore and the Federation of Malaya that the University should be moved out of Singapore to a site some twenty miles away in Federation territory, across the Strait of Johore This project had many attractions, especially politically , but as time passed it became very clear that such a move would meet many obstacles, would cost vast sums of money and would take many years Doubts accumulated of the inherent wisdom of removing from close contact with the life and culture of the leading city of Malaya Growth in numbers—much more rapid than had been expected—produced pressing demands for more facilities now on the Singapore site rather than alternative facilities years hence elsewhere , but action was paralysed by the prospect of ultimate removal.

The financial position was equally inimical to long-term planning. The two Governments had met without demur the annual demands of the University as presented but had made no specific promises for the future as to either recurrent or capital expenses, leaving the academic staff in doubt whether money would always be forthcoming so readily and so unconditionally.

During the past year both site and finance have been publicly discussed and reviewed by the University and the Governments Three main conclusions have been unanimously accepted the project of removal to Johore is abandoned , the University will retain its home in Singapore where it has considerable space for development, but will also, with growth in student numbers and in technical studies in mind, begin a second university centre at Kuala Lumpur, the Federation capital , and finance is assured by a promise of annual Government grants over a five-year period on an escalator basis, plus a minimum capital grant. The money promised is less than the University asked for , but the minimum annual grant is to rise from £640,000 for 1954–55 (against £560,000 in 1953–54) to £780,000 in 1958–59 For capital the University will be largely dependent on further assistance from the Colonial Development and Welfare Fund (from which £1,000,000 is already promised) and from private benefactions These decisions give a firm basis for further progress, and urgently needed new buildings will be started almost at once.

What, on the other side, is the academic basis for progress ? The existing faculties are in arts (including English, oriental studies, geography, history, economics, education and mathematics), science and medicine, making a total of twenty-seven departments Staff has expanded from the 60 taken over from the Colleges to 140 at the beginning of the 1954–55 session Student numbers have grown in five years from 450 to 1,050. New departments added since 1948 include education, Malay studies, Chinese language and literature, philosophy, social medicine, parasitology and orthopædic surgery Social studies, in which a diploma is awarded, has been added as a sub-department of economics, and independent lectureships have been established in the history of art and in child health Although additional buildings are needed, the University is already fortunate in having good and well-equipped laboratories, a large and progressive teaching hospital and substantial general accommodation. By a wise decision, the one important building put up since 1949 has been a well-equipped library which houses a good collection of English books and one of the largest collections of Chinese books in Asia outside China itself.

In maintaining degree standards, the University relies very much on the distinguished scholars from the United Kingdom and elsewhere who act as external examiners and pay regular visits Its M B , B S., like the medical diploma of the former College, is a registrable qualification in the United Kingdom and, more significantly for the reputation of the Medical School, the Malayan diploma in public health begun last year was at once recognized by the General Medical Council. No equally clear-cut 'recognition' is available for non-medical degrees , but students with a University of Malaya honours degree are accepted for higher studies at leading universities and professional institutions elsewhere

Academic standing is judged not only by the first degrees awarded but also by the output of research Here, after five years, it is fair to look at the promise rather than the achievement Recognizing the importance of research, the University immediately provided for a full range of higher degrees To date it has awarded seventeen M A s or M Sc s, three Ph.D s and five M.D s At the commencement of the 1954–55 session, twenty-seven students were registered for higher degrees Much research work is also being pursued by senior members of the staff without formal registration, and there is a steady flow of papers published in learned journals A research unit for social research has been set up, and several research students have been attached under Fulbright arrangements

The University is thus a functioning mechanism, sending a regular stream of graduates into the professions and public services of Malaya—some 70 doctors and dentists a year and 120 non-medical graduates , and prosecuting specific research in all its main branches of study. What are its opportunities ?

First are its teaching opportunities Malaya is progressing steadily towards self-government , the senior Government services, the professions and local business managements will soon be recruiting scarcely any but local men and women They need not all be locally educated , but the University of Malaya ought certainly to provide a high percentage of the university-trained personnel of the Malaya of the future To do that it must broaden the scope of its teaching It must add departments or faculties in engineering, agriculture, law and the complex group of social studies which includes government and political science, applied economics and social anthropology A start is to be made on all these within the next quinquennium, besides developing existing departments.

Such a widening of scope is not too ambitious if full university stature is to be attained, and there is adequate reason to expect a flow of students sufficient to fill these courses and, incidentally, to justify the beginning of university teaching in Kuala Lumpur There are to-day more Malayan young men and women studying at university-level outside the country than there are at the University of Malaya, most of them are studying subjects not yet taught in Malaya, and a good proportion would no doubt have come to Singapore if these subjects had been offered there Furthermore, a very rapid expansion in secondary education is taking place in Malaya. Even allowing for some brake on expansion at the higher levels imposed by shortage of teachers capable of maintaining the necessary standards, the numbers seeking a university education look like doubling in the next decade

Relevant to the question of numbers is the fact that the University to-day draws very little upon the 'Chinese' schools, which provide a self-contained system of primary and secondary education distinct from the 'English' schools and relying mainly on Chinese as a medium of instruction and on Chinese inspiration in general subjects Pupils from such schools qualified for a university education formerly went to China for it There is now a project to create for them a separate institution, to be called the Nanyang University, although they are only a fraction of those from the English schools and could scarcely support a separate university of Western academic standards It is important that they should not be denied entry to the University of Malaya, and means are now being examined by which the language difficulty can be surmounted and a regular channel of entry from these schools established

A university is not, however, just a machine for turning out highly trained professional men Equally important are the spirit, the philosophy and the culture they carry with them. Here the prospective political and social development of the country makes the role of the university even more vital Maintaining the values of life as we see them in the West, and the standards of political and public life, will make great calls on the young men and women who will be filling the public services, the law and other professions in the next five or ten years In living up to its responsibilities in this field, the University has to steer a delicate course in the teaching, encouragement or toleration of political thought and discussion, still more delicate are the susceptibilities in the religious field when students are drawn from so many faiths—Moslem, Confucian, Hindu, Buddhist and Christian In so far as political, philosophical or religious ideas are taught, they tend to become vague distillations of the essential truths of many creeds and to lack sharpness and punch The widely realized problem of how to instil some real philosophy of life in a secular university is particularly difficult in a country of such varied make-up and in which almost all identifiably Western doctrines except Communism are liable to be suspected of a 'Colonial' taint None the less, difficult as the task is, the handing on of the essence of Western culture is one of the greatest of the opportunities of the University of Malaya

So much for what can be taught What of the things to be learned, the research opportunities? In natural science special opportunities arise from the physical situation of Malaya Singapore is barely 1° from the Equator In physics, although claiming no special facilities for pursuing the main lines of current physical research, Singapore is uniquely situated for the study of equatorial meteorology, Malaya can also offer its own special contribution in rock magnetism Probably no other university offers as good facilities for the study of equatorial marine fauna In botany there is the basic study of the behaviour of plants in a virtually seasonless climate, as well as much scope for further systematic work on the rich equatorial flora, and chemistry can, *inter alia*, supplement the work of the botanist with systematic study of the properties of that flora

The geographical situation also opens opportunities of special research in the medical field The distinguished tradition of research in Malaya is still carried on in the Institute for Medical Research at Kuala Lumpur, and is now being supplemented by work in the University Among many special topics attention is being paid to parasitology, local virus diseases and to physiological reactions to the heat conditions of the equatorial tropics

In human or sociological studies, special opportunities arise less from the equatorial situation than from history and economics South-east Asia has always been a meeting-place of cultures, and the ordinary complications of mixed societies are given a special flavour in Malaya by the fact that the diverse races are mixed in such proportions that each one is, statistically speaking, a 'minority'. The very newness of the country—by the standard of the date of effective opening-up to close human settlement most of it is newer than the United States—makes its sociology a living study of pioneering and of the absorption of mass immigration In economics, Malaya provides an outstanding case of the 'export economy' and of dependence on highly fluctuating world markets, and much of the special reaction on the local economy has still been only superficially studied As background to all this, more complete study of the history and geography of both Malaya itself and the surrounding countries is being systematically tackled by enthusiastic teams in the respective University departments In all fields the geographical situation and communication facilities of Singapore justify hopes of its becoming a major centre for the study of South-east Asia as a whole

A third field of opportunity for the University lies in extra-mural work in a much wider sense than usual, implying not merely (indeed scarcely at all) formal teaching outside the University's walls but also encouraging, stimulating and assisting whatever local initiatives develop in the fields of art, music, literature and general study. Already the University is establishing itself in this way as one of the centres where the public may hear good music, watch plays or look at exhibitions of visual art, and as the headquarters or inspiration of national societies such as the Malayan Historical, Science or Mathematical Societies

Lastly, what are the problems of such a university? One major problem already mentioned—how to influence the souls and the philosophical beliefs of its students as well as their minds and their technical knowledge—is bound up with the way the students live. To-day the University of Singapore is more like a British civic university than one of the ancient universities; true, a high proportion live in university residences, but those residences are properly called hostels rather than colleges and have scarcely any of the collegiate atmosphere. The development of that depends on physical facts and will necessitate extensive new building. A second problem is the recruitment of staff. Naturally it is the aim to recruit locally as much as possible, and more than 40 per cent of the staff (including five heads of departments) are Asian; but extensive reliance will be placed for many years on outside recruitment. To-day the non-locals are themselves a very mixed group, countries of origin including, besides the United Kingdom, every other nation in the Commonwealth, Ireland, the United States, Denmark, Sweden, the Netherlands, Switzerland, Germany, Austria, Czechoslovakia, China, Indonesia and Thailand. This diversity of origin broadens the University's scope, but adds to the problems of spiritual unity. The determination to attract staff of the right quality is shown by the very high salaries and allowances offered (for example, assistant lecturers starting at £1,490 per annum actual emoluments and lecturers ranging from £1,638 to £2,688).

Recruitment is linked with a third general problem—the danger of isolation. The fear of being cut off from the intellectual stream of the big universities undoubtedly deters many potential recruits and is a danger in the wider sense to a university the nearest Commonwealth neighbours of which, Hong Kong, Ceylon and Western Australia, are all more than 1,500 miles away. The University reduces the isolation by generous vacation and study leave, by the external examiner system and by seizing every opportunity of attracting distinguished visitors, who can often be caught in Singapore almost literally on the wing as they fly through *en route* to Australia or the Far East. None the less, the maintenance of contacts with Commonwealth, American and European universities is a constant problem, in the solution of which every possible outside help and sympathy are needed. The recent institution of scholarships for the children of United Kingdom staff of Colonial universities by Birmingham is an example of the sympathetic interest required.

Space does not permit of discussing here more localized problems—the administrative complexities of development in Kuala Lumpur as well as Singapore, the linguistic problem of teaching in English to students of diverse mother-tongues, the problems of school educational standards, etc.—but something must be said about costs. All the growing Colonial universities cost a good deal more per student than the average United Kingdom or Commonwealth university. Apart from the inevitable burden of overheads in small institutions, salaries have to be much higher to attract staff, passage and leave grants are expensive and the expenses of external examiners add further to the cost. It must sometimes seem, therefore, as if it would be no more expensive to maintain all the students overseas at older universities. That would be an exaggeration; but in any event this must be regarded as an initial phase of costliness which will pass as more local talent becomes available. The high current costs of operation are properly regarded as part of the capital costs of building up institutions which, in Malaya and elsewhere in the Colonial Empire, represent one of the greatest, if one of the latest, of the contributions of Western influence to the full growth and development of these territories. No better use can be found for further United Kingdom assistance to Colonial development and welfare than a continuance of the generous grants which have made possible the initiation of these overseas university institutions.

RECENT TRENDS OF GLACIER FLUCTUATIONS IN THE NORTH ATLANTIC AREA

A LARGE and varied audience attended a discussion on "Recent Trends of Glacier Fluctuations in the North Atlantic Area" held by the British Glaciological Society in the Department of Geology, Oxford, on November 19. This was the first meeting of the Society to be held in Oxford for some years, and it was opened by Mr. G. Seligman, president of the Society. The main part of the meeting took the form of five short papers given by Mr. C. W. M. Swithinbank (Pembroke College, Oxford), Dr. C. A. M. King (Department of Geography, Nottingham), Dr. M. M. Sweeting (St. Hugh's College, Oxford), Mr. M. F. W. Holland (St. Peter's Hall, Oxford), and Mr. H. Lister (Department of Geography, Cambridge). These papers were mainly concerned with the results derived from recent field-studies on glacier regime and fluctuations in areas around the North Atlantic, particular attention being paid to fluctuations during the past fifteen to twenty years. Prof. Gordon Manley (Bedford College, London) attempted the difficult task of summing up the very diverse contributions and of assessing the extent of the dependence of glacial variations upon present climatic developments. Dr. K. Sandford (Department of Geology, Oxford) was in the chair.

In the first paper, Mr. Swithinbank reviewed the latest work in Scandinavia, where practically every glacier has been in retreat for more than half a century. The rate of retreat increased during the 1930's and caused the disappearance of several small glaciers. The changes of the past ten to fifteen years did not, so far as can be seen at present, reflect either a significant increase or decrease in the prevailing high rate of retreat. We are hampered in a study of recent trends by the small number and indifferent quality of available measurements. A change in the 'state of health' of a glacier is best defined in terms of changing total ice volume and changing material balance. Accumulation and ablation measurements have been made since 1945 on one glacier in western Norway (Storbreen, Jotunheimen), and one in Swedish Lapland (Storglaciaren, Kebnekajse)[1]. The marginal retreat of these two glaciers has not, however, been proportional in single years to the net deficit of their regime. Mr. Swithinbank was therefore distrustful of measurements which referred only to the snout recession of Scandinavian glaciers.

Though most glaciers show a time-lag of several years in their response to climatic change, and some appear to follow a rhythmical advance and retreat that is largely independent of short-period fluctuations, there is in Norway a fairly good correlation between the trend of annual mean air temperatures and the mean rate of recession of the glaciers. While the present glacier trend in western Norway is mainly due to a steady increase in the length of the ablation season, in Swedish Lapland it is apparently caused by rising summer temperatures, which have led to greater rates of melting during the mid-summer months In west, though not in north, Norway there has been also a steadily decreasing winter accumulation This is noteworthy, as it contrasts with a more general trend of increasing precipitation recorded at most of the low-lying meteorological stations in the country

Mr Swithinbank thought that conclusions of great interest are to be expected in a few years time, when we shall be able to compare running means of the yearly volume changes of a number of glaciers with running mean figures of the climatic elements obtained from observations on the glaciers themselves, rather than at places (like most existing stations) which differ from the glacier-covered areas both in altitude and exposure

The subsequent papers dealt with details of glacier fluctuations based on field-studies made in the past few years Dr King discussed the fluctuations of four glaciers draining south from the ice-cap of Vatnajokull in Iceland She said that the evidence included measurements of the glacier snouts carried out since 1932 and also evidence of thinning and retreat from field observations made in 1953 and 1954 The following figures give the long-term and more recent trends

Glacier	1932–53	1951–53
E Skeidararjokull	– 460 m	– 34 m
Morsarjokull	– 557 m	– 33 m
N Skaptafellsjokull	– 800 m	+ 24 m
S Skaptafellsjokull		– 8 m
N Svinafellsjokull	– 540 m	+ 14 5 m
S Svinafellsjokull	– 136 m	+ 13 5 m

These figures show that on Skaptafellsjokull and Svinafellsjokull the retreat is slowing down or reversing, while the other two glaciers continue their rapid retreat S Svinafellsjokull has scarcely retreated at all during the past ten years These observations may be accounted for by the variations in height of the accumulation areas of the glaciers concerned, as shown by the following figures

Glacier	Accumulation area (per cent) above 1,400 m	Accumulation area (per cent) above 1,700 m
Morsarjokull	0	0
Skaptafellsjokull	22	8
Svinafellsjokull	51	22

The evidence of thinning of the glaciers indicates a very substantial loss of volume Morsarjokull has thinned by 90 m since 1904, during this period two of its three tributaries have become disconnected Skeidararjokull during the same period has thinned about 76 m on the evidence of a well-marked trim line Skaptafellsjokull and Svinafellsjokull were joined at their snouts until the rapid retreat caused their separation in 1935 Since this time Skaptafellsjokull has retreated and thinned rapidly, but Svinafellsjokull, particularly at its south end, has stagnated The glacier has, however, thinned by 60 m. recently, as indicated by a very pronounced trim line at this height

The variability of accumulation is marked, which causes considerable variations in glacier budget and fluctuations from glacier to glacier and from year to year Dr. King concluded that the evidence indicated in general a rapid retreat and thinning of the outlet glaciers of S W Vatnajokull, with some exceptions. Those glaciers with the highest accumulation areas are advancing slightly at present

Dr Sweeting gave evidence for recent glacier fluctuations in Spitsbergen, where the glacial recession has been very rapid since 1890 She discussed details recorded by Miss G E Groom and herself in 1953 of the state of the glaciers in Bunsow Land, central Vestspitsbergen In this area the disintegration and thinning of the plateau glaciers have continued, apparently unabated, in the past twenty years Many small glaciers mapped by the Cambridge Spitsbergen Expedition in 1938 have now disappeared All the glaciers examined in Bunsow Land in 1953 showed signs of marked recession Great heaps of moraine now remain in front of gently sloping glacier snouts, in many places the ice is stagnating at its terminal ends Dr Sweeting quoted as an example, in Bjonadalen, in south-east Bunsow Land, a simple confluence system of two glaciers, the long confluent snout of which has become stagnant, this stagnant ice-mass is in process of being severed from its feed glaciers and is becoming a dead-ice patch Dead-ice accumulations were mapped in other valleys in Bunsow Land where the glaciers have retreated to leave only a much attenuated snout in the valley head Some of the steeply inclined cirque-like glaciers have also become detached from their supply areas and are now dead ice.

The behaviour of the major ice fronts in Bunsow Land has been studied since before 1900. The ice front, still largely afloat, of the Nordenskjold glacier has been mapped by a series of Cambridge expeditions since 1938 Between 1938 and 1953 it showed a continuation of the retreat which was so marked a feature of the 1920's and early 1930's, during 1938–49 the retreat averaged 6–15 ft a year[2]

No detailed observations on accumulation and ablation have yet been made in this part of Spitsbergen, but the rate of ablation in 1953 was undoubtedly high. In the last weeks of July and the first weeks of August, during the height of the ablation season, the rate of ablation at 500 m was approximately 29 mm per day

Glacier recession has been less marked in North East Land, an island lying to the north-east of the main island of Vestspitsbergen, which is both much more ice-covered and more 'polar' in character Mr Holland said that recent observations in North East Land tended to confirm the view held by Glen that the ice is in a generally passive state and that it has a negative regime In the southern part of the island there is evidence of wastage of the ice in the presence of high heaps of glacio-fluvial debris and in the tendency for small glaciers to become detached from the main ice-caps The outpouring into the sea of the large ice lobe of Bråsvellbreen from the ice cap of Sorfonna in about 1937 was a spectacular example of the advance of a glacier which probably bore no relation to the present glacial balance and was not an indication of increasing glaciation[3] Mr Holland discussed the possible causes for this advance

The problems concerning glacier fluctuations and regime clearly become more difficult the larger the ice-mass, we have also very little information about the world's large ice-caps These points were stressed by Mr. Lister, recently back from the British North Greenland Expedition Conclusions drawn from a study of the advances and retreats of the glaciers associated with the Greenland ice-cap are likely to be misleading, and the fluctuations of the glaciers in Queen Louise Land do not throw much light upon the glacial balance of the area However, the existence in Queen Louise Land of a well-marked trim line suggests that thinning of the ice there has occurred Preliminary results also suggest that in this part of North Greenland ablation at present exceeds accumulation and that there is a negative balance The recession of the glaciers up the fjords is fairly well established, thinning is not so marked but a new nunatak had appeared[4] There has been a general decline in the accumulation of inland ice, but recent years have shown a slight increase

It has been said that the "intensity of glacial recession and shrinkage in recent decades round the northernmost Atlantic constitutes perhaps the clearest indication, among many, of a climatic fluctuation in this region"[5]. The rise of temperature in the northern hemisphere has reached its maximum value in Vestspitsbergen, where the shipping season has lengthened from three months at the beginning of the century to about seven months in the 1940's[6] Investigations into the causes of glacier fluctuations are therefore of more than glaciological interest It was along these lines that Prof Manley summed up the evidence of the five principal speakers With regard to Mr Swithinbank's remarks, he agreed that each glacier must be treated on its own merits Yet if the aggregate effect on the movement of the firn-line, for example, is taken over a decade and for, say, a score of glaciers, as in Iceland or Switzerland, the evidence for temperature trend is undeniable, further, it is supported by actual instrumental data To Prof. Manley, the fundamental factor linking these varied field investigations around the North Atlantic is that of climate and especially the mean summer temperature He showed the extent of the correspondence between the fluctuations of glaciers and the overall variations since 1700 of the accumulated summer temperatures on British uplands[7]. It was also noteworthy that the accumulated temperatures of the summer months, corresponding with the ablation season on glaciers, varied in much the same way in eastern North America

Other problems of glaciological research, Prof Manley pointed out, had also been raised At what stage did a snow-bed become a glacier ? The small remnants of ice that had been shown in the heads of steep gullies in Spitsbergen begged the question of why cirques had not developed in that area Field-investigation of glacier behaviour is strenuous and it is necessary to accumulate and integrate results before conclusions can be reached Glacier fluctuation in Spitsbergen, and probably also in North-East Greenland, is closely connected with the behaviour of the ocean waters and the extent to which sea ice is formed Ultimately, it will require the collective efforts of many sciences to solve the major riddle, that of ice ages, but field-work will provide the foundation The field-study of glaciers, like all other field-studies, opens up a variety of further problems for others to discuss

Speakers in the later part of the discussion were much exercised with the causal connexion between the recent glacial fluctuations and the present climatic developments Prof H W Ahlmann has already pointed out that the present climatic improvement probably culminated during the 1930's and 1940's, and that in North America the decade 1941–50 was characterized by somewhat lower temperatures and increased precipitation compared with the decade 1931–40[6] The most important factor so far in causing the recession of the glaciers in areas around the north Atlantic has almost certainly been the greatly increased ablation But as Prof. Manley pointed out, a series of wet cool summers like the one we have had in 1954 might well alter the ratio of accumulation to ablation and cause a reversal of the present trend of glacier fluctuations, hence, climatic developments of the near future are of particular significance

M M SWEETING

[1] Ahlmann, H W'son, *Geog Ann*, 33, 90 (1951)
[2] Harland, W B, *Geog J*, 118, 309 (1952)
[3] Glen, A R, *Geog Ann*, 21, 1 (1939)
[4] Koch, I P, and Wegener, A, *Meddelelser om Grönland*, 46, 31 (1912)
[5] Ahlmann, H W'son, "Glaciological Research on the North Atlantic Coasts", Roy Geog Soc Research Series, No 1 (1948)
[6] Ahlmann, H W'son, *Amer Geog Soc*, *N Y* (1953)
[7] Manley, G, *Toronto Proc*, *Roy Met Soc*, 199 (1954)

BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION

ANNUAL GENERAL MEETING

THE thirty-fifth annual general meeting of the British Cotton Industry Research Association was held at the Shirley Institute on Thursday, December 9, the chairman of the Association, Mr. N. G McCulloch, presided In his address he referred to the importance of the long and valuable experience acquired by the Institute over thirty-five years, but he also pointed to the need for periodic reviews of policy in order that the Association should continue to pursue the correct objectives He was particularly concerned with the problems of developing research results and the financing of such development, and with the continued need for close liaison between Institute and mill, in which he thought the trade associations can play a considerable part The honorary treasurer of the Association, Mr J Lindley, reviewed the statement of accounts for the year, and reported that the introduction of the statutory levy has resulted in a considerable increase in the stability of the Association's finances He warned members, however, that, particularly as a result of continuing inflation. but also because of the increasing demands being made by members, increased expenditure in the future was unavoidable

Dr F C Toy, director of research, presented his annual report, and described the previous year as one of great activity in which the maximum efforts of the staff had been required to meet the demands made upon them by members He made particular reference to the newly joined doubling and condenser spinning members, for whom new programmes of work had been begun Dr Toy referred to the increasing popularity of the 'Shirley' automatic size box (referred to by one member as "the greatest advance ever made in sizing technique"), and directed attention to a natural development from the size box—the new cold-slurry sizing process Another programme of work in its early stages was specially mentioned, namely, a fundamental study of the problems concerned with blending fibres, particularly man-made fibres, with cotton and with each other. Dr Toy pointed out that the Institute now has a staff of four hundred and fifty, and he felt sure that the future is full of promise

The Institute's laboratories were open for inspection for two full days, when the whole of the staff was available for consultation, and thirty special exhibits had been prepared. For spinners, three practical results of the work of the Spinning Department were on view: a new type of delivery box for use in the pneumatic conveyance of cotton, a guide for controlling the arrangement of yarns in manifold threads, and the first part of a miniature spinning plant for use in the mill. For the more scientifically-minded, apparatus was shown which had been designed for the study of factors affecting yarn behaviour during ring-spinning. This physical examination is a complicated one, demanding simultaneous measurement of such factors as balloon shape, yarn tensions and ring friction.

In the Weaving Department sizing was in progress, using the automatic size box fed with cold starch slurries. The use of these slurries is only possible because of the control exercised by the automatic size box, which compensates for viscosity changes that occur as the cold slurry is gelatinized; there is considerable saving in the boiling time required and in the ease of handling the size. The samples of cloth woven from slurry-sized warps were shown to be quite satisfactory. Another exhibit concerned with sizing illustrated the work which is directed towards elucidating the difficulties arising in removing starch, during finishing, from fabrics woven from spun viscose. This work is fundamental and involves studying the effect of the rate of drying on the solubility of size films, and is related to studies of the molecular structure resulting from different drying histories. An exhibit in another department of the Institute showed the results of investigations of several new sizes, which had been examined from the point of view of ease of removal in finishing. In the Weaving Shed there was a demonstration of a pneumatic device designed at the Institute to prevent the defect of 'lashing-in'. This defect arises on certain multi-shuttle looms, when weft running from the fabric to a temporarily inoperative shuttle in the shuttle box is carried into the fabric by the operative shuttle.

In the Finishing Department, considerable interest was aroused by a new experimental raising machine, designed at the Institute to study fundamentally the process of raising, and initially the different types of drive to the raising rollers and their power requirements. Much work has been done in this Department on measuring the areas of contact between mangle and calender bowls, and two simple methods were shown which have been specially designed for works use. The bowl deflexion indicator, for example, measures the deflexion of bowls under load and indicates the amount of camber required to correct for this, and to give regular mangling or calendering along the length of the bowl. Of particular interest to chemists were the results shown of an investigation on the minimum requirements of sodium hydroxide and sodium hydrosulphite for a number of vat dyes in the pad steam-dyeing process.

The Rayon Department at the Institute is concerned with all fibres (other than cotton) which can be processed on cotton-type machinery, including viscose and cellulose acetate, and also nylon, 'Terylene' and other synthetic fibres. An interesting exhibit was that of work which has proceeded for some years on the effect of molecular weight and molecular arrangement on the tensile properties of cellulose acetate monofilaments. Also in the Rayon Department was a demonstration of methods of analysing fibre blends. The development of these techniques was a necessary part of the fibre-blending programme referred to in his address by Dr. Toy. Crease-resistant rayon fabrics are now produced in large quantities, and an attempt is being made to relate the mechanical performance of these fabrics to the physical properties of the fibres and the chemistry of the various processes involved.

The Silk Department at the Institute serves a group of members who, before the War, were concerned almost solely with this fibre. These members have more recently become increasingly interested in modern synthetic fibres, nylon and 'Terylene' in particular. There was a demonstration of an experimental machine designed to investigate the hot-stretching of nylon and 'Terylene'. The Department has done much pioneer fundamental work on the chemical constitution of silk fibroin and sericin, particularly by chromatographic and X-ray analysis, and there was a demonstration of how the chemical constitution of different silk fibroins affects some of their textile properties.

An exhibit of particular importance, and one which aroused great interest, was of thirty-five instruments devised at the Shirley Institute for development work, and particularly for quality control in the mill. Many of these instruments are now manufactured for and sold by Shirley Developments, Ltd., the commercial subsidiary of the Association, recently set up to exploit its inventions. Prototypes of such instruments, and, indeed, all new equipment, large or small, are made in the Institute's Engineering Department, which comprises drawing office and combined engineering and instrument workshop. Examples of the productions of this Department were shown in the shop, including an experimental suction drier for the Finishing Department, and parts of the miniature spinning plant for mill use, mentioned above.

The Institute's work on the elimination of problems in the mill due to static electricity is complete for the time, and there was a display of the various devices which have been produced. This work on the elimination of static has, however, stimulated a more fundamental programme on the mechanism of static production, which physicists were able to discuss with the members of the staff concerned. This work may well be closely connected with the difficult problem of reducing the tendency of textiles to acquire temporary or permanent soiling, and the work of the Institute in this field was demonstrated, and more particularly an apparatus designed to measure atmospheric dirtiness, which has already received considerable use in mills.

There are many empirical instruments and methods in commercial use for assessing the textile properties of fibres, yarn and fabrics, some of them originating in the United States. The policy of the Institute is to examine critically all such instruments and methods and report its views to members. Many of these methods were shown in operation.

The annual general meeting gave members a fuller opportunity of visiting their central research organization than has been afforded since the War. The result was highly satisfactory in that there was a large attendance of more than seven hundred visitors. Members and staff were equally pleased with the success of the occasion—members with the wide range of the work proceeding, and the staff with the interest shown by the visitors and the extent to which their work was understood and appreciated.

OBITUARIES

Sir Arthur Keith, F.R.S.

With the death of Arthur Keith on January 7, there has passed one of the most outstanding exponents in his time of human and comparative anatomy and of physical anthropology.

Arthur Keith, the son of an Aberdeenshire farmer, John Keith, was born in 1866. In 1884 he entered Marischal College as a medical student, and was there brought under the influence of James Trail, the botanist, and John Struthers, the anatomist, both of whom provided a powerful inspiration which directed him towards a scientific career. After taking medical qualifications at Aberdeen, there followed a brief interlude when he undertook medical work for a gold-mining company in Siam. But it was an interlude of importance, for in his spare time Keith made anatomical studies of the gibbons and monkeys which inhabit the tropical jungles of the Far East and thus laid the foundation of what was to become one of the main themes of his life's work, the comparative anatomy of man and apes. His first paper in this field, which appeared in 1894, dealt with the ligamentous structures of the catarrhine monkeys. In his autobiography (published in 1950), Keith records that on his return from Siam in 1892 he had already decided to embark on an anatomical career; but he had an anxious period of waiting in very straitened circumstances before he was appointed lecturer in anatomy at the London Hospital Medical School. He occupied this post for thirteen years, during which he fully established his reputation as an anatomist by his work on the mechanism of respiration and on the comparative morphology of the heart, and by his important demonstration, in collaboration with Martin Flack, of the sinu-auricular mode of the heart. In 1908 he was appointed to the much coveted position of Conservator of the Museum of the Royal College of Surgeons, a position which he occupied with great distinction until his retirement in 1933.

Arthur Keith's name will always be linked with the Museum of the Royal College of Surgeons, just as, in his time, a reference to the College immediately called to mind the name of Arthur Keith. His distinguished predecessors were essentially academic zoologists and their interests scarcely encroached on the clinical field. But, with his clinical interests and experience, Keith focused attention on the value of the Museum as one of the finest records of the structure and history of the human body, with particular reference to the surgical disabilities and disorders which may affect it. No doubt he was better known in popular circles for his work on human evolution and fossil man; but he was no less well known in the anatomical and clinical field for his numerous and important contributions to the study of applied anatomy. In 1901 there appeared the first edition of his book "Human Embryology and Morphology", the sixth edition of which was published in 1947. The embryology of this book was not based (except to a very slight extent) on original observations; but it had the novel feature of linking together the facts of embryological development with those of comparative anatomy and evolution, and of interpreting the former in terms of the latter. For this reason it proved far more stimulating to students than the more academic and orthodox text-books on human embryology, and it has been very widely used for many years. It exemplifies particularly well the remarkable facility which Keith possessed of clarifying and illuminating an abstruse subject by presenting it in a rather unusual perspective.

At the Royal College of Surgeons, Keith rapidly acquired a high reputation as a lecturer. Although by ordinary standards his delivery was not particularly good—as a speaker he was somewhat halting and hesitant—he had a capacity for making such intimate contact with his audience that each member almost felt that the lecturer was discussing problems with himself personally. From 1910 onwards, Keith devoted more and more time to the study of fossil man, and soon came to be recognized as one of the foremost authorities on this subject. The results of his investigations were published partly in book form (for example, "The Antiquity of Man", 1915) and partly in a series of scientific papers and essays. Many of the conclusions which he formulated in his earlier years, particularly his estimates of a great antiquity for modern types of man based on remains such as the Galley Hill skeleton and the Ipswich skeleton, proved later to be founded on insecure evidence. But it has to be realized that at that time fossil specimens of early man were very few and very fragmentary, and many of the techniques which are available to palæo-anthropologists to-day were as yet undeveloped. One of Keith's outstanding characteristics was a combination of great intellectual honesty with a sincere humility, a combination which is surely a mark of the truly scientific mind, and he was always ready to admit errors of interpretation when the accumulation of evidence demonstrated these. Perhaps no instance of this characteristic is more striking than his immediate acceptance of the fraudulency of the Piltdown specimens when the evidence for this was placed before him last year. As a matter of fact (though he did not himself realize it at the time) Keith actually took the first step which forty years later led to the exposure of the forgery, by demonstrating that the Piltdown skull was that of a large-brained individual similar to *Homo sapiens* and by no means the microcephalic and somewhat simian type of skull which had been exhibited in the first reconstruction from the fragmentary remains.

In 1927, Keith was president of the British Association, and it was the result of his influence on that occasion that Darwin's old home, Downe House, was acquired by the British Association. It was also his influence which led the late Sir Buckston Browne to buy and endow an estate near by for use as an institute of experimental surgery. When Keith retired from his position as Conservator of the Royal College of Surgeons in 1933, he was appointed Master of the Buckston Browne Institute, and occupied that position until he died. He continued his anthropological work there, and in 1939 there appeared (in collaboration with T. D. McCown) what was perhaps one of his best works in this field, an elaborate and careful study of the remains of palæolithic man which had been found at Mt. Carmel in Palestine. He also published in 1948 a book on "A New Theory of Evolution", in which he stressed (and in some ways perhaps rather overstressed) the factor of social segregation in racial diversification, and in 1950 his "Autobiography" appeared.

Sir Arthur Keith's scientific eminence brought him many honours and distinctions; but he remained always a modest and unassuming man. Above all, he will be remembered for his kindly personality. He was (as he himself records in his autobiography) an individualist and did not make friends very easily among his immediate colleagues, but, for all that, he earned an affectionate regard from everyone who had met him, even from the most uncompromising of his scientific opponents

W E Le Gros Clark

Mr J E Sears, C B E

John Edward Sears, formerly superintendent of the Metrology Division of the National Physical Laboratory and, until recently, president of the International Committee of Weights and Measures, died suddenly in Teddington Memorial Hospital on December 21 at the age of seventy-one

The son of the late John Edward Sears, formerly member of parliament for Cheltenham, he was educated at Mill Hill and St John's College, Cambridge, of which he was a Scholar He obtained first-classes in mathematics and mechanical sciences and, in 1907, was awarded the University's John Winbolt Prize for studies in civil engineering He served an apprenticeship with Wigham Richardson, Ltd, Walker-on-Tyne In 1910 he joined the National Physical Laboratory to take charge of the metrology section of the Physics Division and thus became responsible for maintaining the Laboratory standards of measurement in length, mass, area, volume and density, as well as for the associated verification work, including the testing of precision engineering measuring equipment and gauges In 1913, as a consequence of the transfer of test work from Kew Observatory to Teddington, the testing of watches, chronometers, hydrometers, barometers and aneroids was added to the duties of Mr Sears's section During the First World War these duties greatly increased, especially in the development of engineering standards, measuring techniques and apparatus for the verification of all types of limit gauges, of which more than a million were tested at the National Physical Laboratory—a demand upon the Laboratory which arose from the application by the Ministry of Munitions of the principles of interchangeable manufacture to quantity production of weapons and ammunition For his services to the country, Mr Sears was made C B E. in 1920. Another consequence was that his section became established in 1918 as the Metrology Division, with himself as its first superintendent, a post that he held until his retirement in 1946 During 1921–32 he was concurrently deputy warden of the standards at the Board of Trade

Mr. Sears's pioneer work in metrology is without parallel in Britain He combined outstanding powers of leadership and organization, a broad scientific knowledge, a flair for design and a clear perception of the basic metrological principles These qualities, with his numerous contributions to the literature, his initiation and supervision of several researches of fundamental importance and the many examples of prototype measuring equipment developed under his personal direction, brought the Laboratory international renown in the subject which was of such absorbing interest to him Among the work with which his name is especially associated may be mentioned a determination of the yard and the metre in wave-lengths of light, and of the refractive index and dispersion of air

Mr Sears was a member of the Institution of Mechanical Engineers and in 1948 he was awarded part of the Institution's Clayton Prize for his services to engineering science and manufacture by research and development in metrology and gauging His presence on committees of the British Standards Institution was always in demand, particularly as chairman, and he continued his work for the Institution until the end He was a member of the Hodgson Committee of the Board of Trade which reported in 1951 its recommendations for the revision of weights and measures legislation Only in October last he retired from the International Committee of Weights and Measures, to which he had been elected in 1930 His election as president in 1946, a position of considerable influence and renown in the international metric organization, was a great honour not only to himself but also to the United Kingdom

In earlier days Mr Sears was a skilled exponent of the English style of skating, and he took a leading part in many of the social activities of the National Physical Laboratory He had a keen interest in gardening and was a Fellow of the Royal Horticultural Society He married in 1919 Kathleen Lucy, daughter of the late Edward Wadsworth, who survives him together with a son and two daughters

H Barrell

NEWS and VIEWS

Rhodesia University College Appeal

The inaugural board of the Rhodesia University College has prepared a handsome illustrated brochure for circulation as a part of its campaign for funds and with the object of publicizing the College generally (see also p 181) Messages are recorded therein from Lord Llewellyn, the Governor-General of the Federation of Rhodesia and Nyasaland, from Sir Godfrey Huggins, the Prime Minister of the Federation, and from other distinguished men An outline of the history of the founding of the Rhodesia University College is given, and the 'special relationship' with the University of London which will exist in the early years is discussed An artist's drawing of the University as it is expected to appear when the proposed buildings are completed shows an imaginative treatment of the site, which is on the outskirts of Salisbury, Southern Rhodesia The £450,000 for which the present appeal is launched is the balance still needed of the £2,000,000 required during the early years of the College's existence Subscriptions and any requests for further information should be addressed to the Secretary, Rhodesia University College, 115 Baker Avenue, Salisbury, Southern Rhodesia.

Dr Walter Adams, C M G, O B E

Dr. Walter Adams has been appointed the successor of Dr W Rollo as principal of Rhodesia University College from November 1955, when Dr Rollo's interim appointment comes to its close Dr Adams is at present secretary of the Inter-University Council for Higher Education in the Colonies, an appointment which he has held since the inception of the Council in 1946 He was born in 1906, and graduated at University College, London, with first-class honours in history, in 1926. Between 1926 and 1933 he held a number of research and teaching appointments in history in the University of London In 1933 he became general secretary to the Society for the Protection of Science and Learning, a body which did invaluable work in helping to place academic refugees from Germany and other places in suitable positions In 1938 he became secretary of the London School of Economics and Political Science, University of London—a position which he held until he took up his present one, though during 1941–45 he was seconded for service with the Foreign Office, spending some time in Washington as deputy head of the British Political Warfare Mission to the United States He was made O B E in 1945 and C M G. in 1952 In his present post, Dr Adams has necessarily travelled widely and has obtained much experience of the problems of university education in Colonial territories Early in 1954 he was awarded the honorary degree of LL D by the Royal University of Malta He will take to the Federated Territories of Central Africa, which he already knows, a knowledge of the educational problems to be faced in multi-racial territories which few can rival The great experiment in higher education upon which Central Africa is about to embark needs men of integrity, experience and forcefulness for its successful outcome, and in Dr Adams a principal has been found who, like Dr Rollo before him, enjoys to the full these and many other distinguished attributes.

Sir Bernard Keen, F R.S.

Sir Bernard Keen, who has been director of the East African Agriculture and Forestry Research Organization since 1947 (see *Nature*, **160**, 184, 1947), is retiring in August He was the first physicist to tackle soil problems in Great Britain This pioneering work at Rothamsted Experimental Station opened up a hitherto neglected line in pure physics—the study of water distribution and movement in porous materials—as well as providing practical applications to agriculture, notably in soil cultivation, evaporation and transpiration Hydrological problems of much importance in connexion with water resources were also clarified by the work of the Soil Physics Department Apart from two years secondment (1929–31) to reorganize the Imperial Institute of Agricultural Research in India, and extensive visits to the United States and South Africa, he remained at Rothamsted as head of the Soil Physics Department and assistant director until 1943 During 1943–45 he was scientific adviser to the Middle East Supply Centre In 1946 he was appointed adviser on soil conservation to the Government of Palestine, and chairman of a U K Government Mission to West Africa on vegetable oil production In 1947 he made an extensive tour of East Africa to advise on regional research The outcome was the adoption of a Colonial Development and Welfare Scheme to create the East African Agriculture and Forestry Research Organization, of which he became the first director A nucleus of staff was available at the East African Agricultural Research Institute at Amani in Tanganyika, which was absorbed into the new Organization The staff was increased by recruitment as the laboratories and experimental farm at the new headquarters near Nairobi approached completion Much attention was given to the important problems of co-ordination between the long-range research of a regional organization and the territorial investigations conducted by the Agriculture, Forestry and Veterinary Departments of Kenya, Tanganyika and Uganda Close liaison was also established with other bodies, such as the Cotton Research Station of the Empire Cotton Growing Corporation, the East African Tea Research Institute, the Overseas Food Corporation, and the Tanganyika Sisal Association Research Station

Chemistry at Glasgow

Prof D H R Barton, F R S

D H R Barton, who has been appointed regius professor of chemistry in the University of Glasgow in succession to Prof J W Cook (see *Nature*, **173**, 61, 1954), graduated at the Imperial College of Science and Technology, University of London, in 1940 He obtained the Ph D degree for work under Sir Ian Heilbron in 1942 and engaged in government work during 1942–44 After a short time in industry, he returned to the Imperial College to work in the Department of Inorganic and Physical Chemistry under Prof H V. A Briscoe, at first as a junior member of staff and later as an I C I Research Fellow. After a year as visiting lecturer in the chemistry of natural products at Harvard University, where he understudied Prof R B Woodward, Dr Barton returned to Britain to take up an appointment as reader in organic chemistry at Birkbeck College, University of London, he was elected professor of organic chemistry in the University of London in 1953 Prof Barton was Harrison Memorial prizeman of the Chemical Society in 1948 and the first Corday-Morgan medallist of that Society in 1951 In 1952 he was a Tilden lecturer of the Chemical Society and was elected to the fellowship of the Royal Society in 1954 His scientific work is summarized in more than a hundred scientific communications in organic and physical-organic chemistry He is responsible, in part, for the development of molecular rotation correlations and conformational analysis, concepts which are contributing greatly to the current rapid growth of alicyclic natural-product chemistry

The International Union of Biochemistry

The International Union of Biochemistry, which was founded on March 1, 1953, was formally constituted at its first general assembly, held in London during January 5–6 Of the fifteen countries which adhere to the Union to date, the following twelve were represented at the Assembly Austria, Belgium, Denmark, France, Germany, Italy, Japan, the Netherlands, Sweden, Great Britain, U S A and U S S R The Assembly elected the Council of the Union, and the Council appointed from among its members the following office-bearers *President*, Prof M Florkin (Belgium), *Treasurer*, Prof E H Stotz (U S A), *Secretary-General*, Prof. R. H. S. Thompson (Great Britain) The following delegates from the various countries at present adhering to the Union make up the remaining members of the Council Prof S Akabori (Japan), Prof J Courtois (France), Academician V A Engelhardt (U S S R), Prof A H Ennor (Australia), Prof K Felix (Germany), Prof E Hammarsten (Sweden), Prof. O Hoffmann-Ostenhof (Austria), Prof K Linderstrøm-Lang (Denmark), Prof. K Lohmann (Germany), Prof R Nicolaysen (Norway), Prof S. Ochoa (U S A), Academician A. I Oparine (U S S R), Sir Rudolph Peters (Great Britain), Prof J Roche (France), Prof A Rossi-Fanelli (Italy), Prof A. Virtanen (Finland) and Prof. H. G. K. Westenbrink (Netherlands). Sir Charles Harington, the former chairman of the International Committee for Biochemistry which was set up at the first International Congress of Biochemistry at Cambridge in 1949, was elected an honorary member of the Council. Following on the unanimous decision of the Assembly, a formal application has now been made on behalf of the Union for adherence to the International Council of Scientific Unions

British Universities Film Council

THE report of the British Universities Film Council for 1953–54 is the sixth since its foundation, which was largely due to the initiative of members of the University Educational Film Council of Cambridge The Council has welcomed the Universities of Aberdeen and Manchester to ordinary membership, making this total now thirty-one, the Scientific Film Association has been admitted to associate membership The report refers to a few of the many activities of the British Universities Film Council, one of which is the issue to all member institutions of a card index giving full particulars of 16-mm films likely to be of use at some stage or other in teaching at university-level or research This list is useful for preliminary reference purposes and gives, under subject headings, the titles of index films Realizing that such a carefully prepared and comprehensive list may be of value to many people and organizations besides their members, the British Universities Film Council has made copies available to all who are interested They may be obtained from the Catalogue Secretary, Royal Technical College, Glasgow

Health Education throughout the World

THE Fifth World Health Assembly, held in May 1952, made provision for the convening of an expert committee on the health education of the public This committee held its first meeting in Paris during December 1953, and its report has now been published (Technical Report Series No 89 Expert Committee on Health Education of the Public First Report Pp 41 (Geneva World Health Organization, London H M Stationery Office, 1954) 1 Swiss franc, 1*s* 9*d* net, 0 25 dollar) The committee tried to outline the way people learn, and the role of the educator in health programmes, to state the broad principles of programme planning, evaluation and organization, and to describe the development and use of methods and media, and the desirable training of personnel Particular attention has been given to the importance of the learner, the 'consumer' of health education, too often in the past health education activities have relied on the wide use of educational media with insufficient consideration of the people for whom they were intended. The report also contains examples of how actual health education campaigns have been carried out in rural, semi-rural and urban areas It would be interesting to know whether health educators throughout the world gain more from these three short case-studies or from the detailed statement of general principles which forms the bulk of the report

Interaction in Effects of Plant Growth Substances

VARIOUS interactions in the physiological effects of growth substances on plant development have been investigated and discussed by G E Blackman and R C Robertson-Cuninghame (*J Exp Bot*, **5**, No 14, 184, 1954) The interrelated effects of 3-indolylacetic acid and sodium 2 4-dichlorophenoxyacetate on the growth and development of *Lemna minor* and *Helianthus annuus* have been investigated by means of multifactorial experiments, involving three to five levels of each compound A clonal population of *L minor* was maintained under constant conditions of light (550 foot-candles) and temperature (25° C) and the growth regulators were added to a phosphate-buffered culture solution (*p*H 5 1) which was changed every two days In the *H annuus* experiments the compounds, in aqueous solution, were placed by means of a micro-pipette on the leaves of young plants grown in a greenhouse or in the open Indolylacetic acid, at concentrations up to 25 p p m, increases the relative growth-rate of *L minor* on either a dry-weight or frond-area basis Sodium dichlorophenoxyacetate at 0 025 p p m. has little effect on growth, but at and above concentrations of 0 2 p p m growth is depressed The ratio of frond area to total dry weight is increased by indolylacetic acid, but is depressed by the phenoxyacetate In the presence of indolylacetic acid, more particularly at the higher levels, the relative inhibition of growth caused by sodium dichlorophenoxyacetate is reduced Various results with *Helianthus annuus* are also described The authors conclude that the results which they have obtained in these experiments cannot be explained on the concept of wholly additive effects There is evidence that the compounds can mutually interfere in their actions, and it would seem that more than one mechanism is involved. Many of the results can be satisfactorily interpreted on the basis that the two compounds act on a common system and that they compete with one another, but the results are not compatible with the postulate that the dichlorophenoxyacetic acid directly inactivates indolylacetic acid.

Some Tungsten and Molybdenum Products

ELECTRO-ALLOYS, LTD, 47–49 Brunel Road, Acton, London, W 3, have issued an attractive and informative illustrated catalogue of their tungsten and molybdenum products The content is printed in three languages—English, French and German—and covers the use of tungsten as a contact material, tungsten and molybdenum as lead-in-wires for glass to metal seals, tungsten welding electrodes for inert-gas arc welding, molybdenum tubes and rods, tungsten anodes for X-ray tubes, tungsten and molybdenum heaters for vacuum metallizing plant and for other special components required for the electronic and associated industries. The technical and physical characteristics of the two metals are clearly stated, whereas both metals have high melting points, low coefficients of thermal expansion and relatively good electrical conductivities at room temperature, their mechanical properties differ in that tungsten cannot be turned, threaded or drilled

The British Gelatine and Glue Research Association

THE annual general meeting of the British Gelatine and Glue Research Association was held on December 8 at the Connaught Rooms, London, W C 2 Mr S G Hudson (Messrs Richard Hodgson and Sons, Ltd.), chairman of council, was in the chair In presenting the annual report, Mr Hudson commented on the extent of the Association's scientific publications, and on the facilities now available to assist member firms Mr A G Ward, director of research, described how the original decision of the industry, to concentrate the work of the Association on fundamental research, was gradually giving rise to results of practical significance. Mr. G. W. Odey (Messrs. Barrow, Hepburn and Gale, Ltd.) was re-elected president. Mr. Odey stressed the importance of applying the most intensive scientific examination to natural products to make the greatest use of the structure with which they have been endowed. There were no changes in the Council or Committees of the Association.

Agricultural Scholarships

The Ministry of Agriculture and Fisheries is offering a limited number of senior and junior scholarships to the sons and daughters of agricultural workmen, smallholders and other rural workers, and to persons who have been paid workers on the land for at least three years. The scholarships are for courses in an agricultural or allied subject, including veterinary science, at university departments of agriculture, agricultural colleges and farm institutes. Candidates must have attained the age of seventeen by September 30. Further information can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Room 313), 1 Cambridge Terrace, Regent's Park, London, N.W.1, or from education offices of county councils.

The Night Sky in February

Full moon occurs on Feb. 7d. 01h. 43m., U.T., and new moon on Feb. 22d. 15h. 54m. The following conjunctions with the moon take place: Feb. 5d. 07h., Jupiter 2° N.; Feb. 14d. 14h., Saturn 6° N.; Feb. 18d. 21h., Venus 1° N.; Feb. 21d. 08h., Mercury 0·5° S.; Feb. 26d. 20h., Mars 4° S. Mercury sets at 18h. 25m., on Feb. 1, which is about 1½ hr. after sunset, and will be visible in the western sky; but the planet is rapidly drawing closer to the sun, with which it is in inferior conjunction on Feb. 12. Towards the end of the month it rises about an hour before the sun, but its declination is then 15° S. and it will not be an easy object to see. Venus rises at 4h. 45m., 5h., and 5h. 10m. at the beginning, middle and end of the month, respectively, and is visible in the eastern sky; but owing to its fairly large southern declination it does not attain a great altitude. Its stellar magnitude varies from −4 to −3·8 and the visible portion of its illuminated disk from 0·547 to 0·650. The distance of Venus from the earth varies from 67 to 86 millions of miles during February. Mars sets about 22h. 25m. during the month and is visible in Pisces from which it moves into Aries, its stellar magnitude varying from 1·2 to 1·4, largely owing to its distance from the earth increasing by nearly 20 million miles during February. Jupiter sets in the morning hours, being visible during the night; its times of setting are 7h., 6h. and 5h., on Feb. 1, 14 and 28, respectively, and it has a westward movement in Gemini, its stellar magnitude varying from −2·1 to −2·0, the decrease in brightness being due to its distance from the earth increasing by 23 million miles during the month. Saturn rises at 1h. 55m., 1h. 05m. and 0h. 10m. at the beginning, middle and end of the month, respectively. It moves slowly towards γ Librae but is stationary at the end of the month, after which it has a westward movement. Its stellar magnitude is 0·7 at the beginning and 0·65 at the end of the month, owing to its distance from the earth decreasing by 42 million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Feb. 1d. 0h. 19·0m., ζ Ari (*D*); Feb. 2d. 19h. 14·8m., 103 Tau (*D*); Feb. 3d. 18h. 11·9m., 3 Gem *m* (*D*); Feb. 4d. 1h. 05·3m., μ Gem (*D*); Feb. 4d. 1h. 46·6m., μ Gem. (*R*); Feb. 4d. 23h. 45·7m., 56 Gem (*D*); Feb. 10d. 6h. 01·4m., 13 B. Vir (*R*); Feb. 28d. 19h. 02·6m., 133 *B*. Tau (*D*); Feb. 28d. 22h. 08·3m., 32 Tau (*D*), where *R* and *D* refer to reappearance and disappearance, respectively.

Announcements

The second International Seaweed Symposium will be held in the Norwegian Technical University, Trondheim, during July 13–17. Further information can be obtained from Prof. T. Braarud, Blindern, Oslo.

The annual conference of the Museums Association will be held at Birmingham during July 4–9. Further information can be obtained from the Secretary, Museums Association, 33 Fitzroy Street, Fitzroy Square, London, W.1.

The eighth Laboratory Animals Bureau Congress will be held in Oxford during March 28–29. The third symposium on "Breeding of Laboratory Animals", organized by the Bureau, will be held at the Royal Society of Medicine on May 9. Further information can be obtained from the Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3.

The annual Spring Conferences in the Department of Industrial Metallurgy, University of Birmingham, will be held during March 14–15. The subject for March 14 will be "Graphitization in Cast Irons", and for March 15 "The Structure and Properties of Electrodeposited Metals and Alloys". Further information can be obtained from the Secretary, Department of Industrial Metallurgy, The University, Birmingham 15.

The Massachusetts Institute of Technology is offering assistantships and fellowships for students taking the two-year course leading to the degree of master of science in industrial management. Assistantships are valued at 1,640 dollars and fellowships at 2,300 (3,000 for married students) dollars a year. Further information can be obtained from the Chairman of the Graduate Committee, School of Industrial Management, Massachusetts Institute of Technology, Cambridge 39, Mass., U.S.A.

The Trustees of the Lady Tata Memorial Fund invite applications for grants, scholarships or fellowships for research on diseases of the blood, with special reference to leukæmia, during the academic year beginning on October 1, 1955. Further particulars and forms of application may be obtained by writing to the Secretary of the (European) Scientific Advisory Committee, Lady Tata Memorial Trust, 38 Old Queen Street, London, S.W.1; applications must be submitted before March 31.

The Worshipful Company of Glass-Sellers of London is offering up to four scholarships in glass technology tenable at the University of Sheffield which, in suitable circumstances, qualify for supplementation by the Ministry of Education up to the full value of State scholarships. The scholarship examination consists of papers in chemistry, physics and pure mathematics (two as primary subjects and one as a secondary subject) together with an English language paper. Applications for entry should be made to the Registrar, University of Sheffield, Sheffield 10, before February 26.

SURVEY OF FIELD THEORY

AUTUMN MEETING OF THE PHYSICAL SOCIETY

MOST meetings of the Physical Society are intended either for the presentation of original papers or for hearing a special lecture by a distinguished scientist, usually the recipient of one of the Society's awards. The meeting held at the University of Birmingham on December 14–15 was of a rather different type. It may fairly be described as a conducted tour of one of the most interesting regions of the frontier of our present knowledge. The 'guides' were a team of specialists on field theory, under the leadership of Prof. R. E. Peierls, who gave the introductory lecture on the first day, when the president of the Physical Society, Prof. H. S. W. Massey, took the chair. The meeting was intended for experimentalists with a general knowledge of quantum mechanics and for theoreticians who do not specialize in field theory.

The lectures themselves were highly condensed summaries, so that it is not possible to summarize them further, but a general indication of their contents may be of interest to readers of *Nature*. Prof. Peierls, in the opening lecture, introduced the fundamental ideas, starting with a consideration of the normal modes of vibration of a solid. He emphasized the method of specifying quantum numbers for the different frequencies and derived from this the picture of 'sound quanta'. These sound quanta, known as 'phonons' in the physics of the solid state, carry the vibrational energy like separate particles. Prof. Peierls then discussed the Fourier analysis of the electromagnetic radiation field and its quantization. Again the quantum numbers for different frequencies specify the field, and the photons replace the phonons. He extended the description to static fields considered in terms of an exchange of longitudinal photons between the charges. The skeleton in the cupboard—the infinite energies—was brought out, rattled and then put back again. Field theorists appear to have a normal vibration between two states: in one they believe they have solved the problem of the infinities, and in the other they know that they have not. Just at present, the first state seems to have the higher occupation number. Prof. Peierls described the virtual processes in which the field theorist becomes a dishonest accountant who embezzles energy but is never found out because he makes restitution within a time fixed by the uncertainty relation.

Dr. A. Salam (St. John's College, Cambridge) gave a more detailed analysis of field quantization and extended the analysis to a field of "photons of non-zero rest mass" defined by the Klein–Gordon equation. He showed that the 'particles' had some at least of the properties of π-mesons. He expounded and re-interpreted the Dirac theory of the electron. Dr. P. T. Matthews discussed interaction between fields and analysed a number of virtual processes. These virtual processes play a very important part in, and are a distinctive feature of, modern field theory. The scattering of a photon of frequency ν by an atom which has two states of energy E_1 and E_0 is regarded as including an intermediate process in which the photon is absorbed and the atom goes from E_0 to E_1, but since $h\nu$ is not even approximately equal to $E_1 - E_0$, energy is not conserved in this process. However, there is a second process in which the photon is emitted in a new direction and the atom returns to its original state. The second stage also 'breaks' the conservation law, but the two stages taken together do not, and there is no observable breach of the law. The 'ordinary physicist' who is just reconciling himself to this situation is then told that he must also accept a situation in which the photon is emitted from the atom in changing from state E_0 to state E_1, that is, 'before' the absorption of the incident photon. He is in the position of a bank manager who has agreed, in principle, that he will grant overdrafts and is then approached by someone who wishes to 'open an account' with an overdraft! As Dr. Matthews showed, there is no logical difference, but the psychological impact of the unfamiliar idea is sharper. He showed that successive virtual processes may produce unexpected observable effects. This gave a theory of the Lamb–Retherford shift and of the 'anomalous' magnetic moment of the electron. He explained the difficulty of meson theory which arises because the fundamental constant $g^2/\hbar c$ is probably of order 10, whereas the corresponding constant in electron theory, $e^2/\hbar c$, is 1/137.

During the discussion on these papers, experimentalists asked what the field theorists had to say about experiments in which particles seem to be very individual, for example, the observation of the track of a meson in an emulsion. Prof. Peierls stated the conditions in which the particle concept remains useful, but emphasized that the field concepts are an essential feature of any relativistic theory of interactions. There was a certain amount of friendly banter between the lecturers and some of the experimentalists in the audience concerning the question whether theory had preceded or followed certain experimental results. If an onlooker may comment on this private contest, I feel that life would be dreadfully dull for the experimentalist if the theoretician could predict in advance the results of his experiments. The theory which is most useful to the experimentalist is the one which most clearly defines a limited area in which crucial experiments may be expected to produce important results.

The three lectures on the second day dealt chiefly with field interactions. Dr. Matthews considered the information about spin, parity, etc., which is derived from studies of the disintegration of π-mesons and their interactions with nucleons. The independence of charge shown by nucleon–nucleon forces was discussed and the concept of isotopic spin was introduced. Dr. G. Feldman described meson production and scattering experiments, giving particular attention to the high-energy resonance effects obtained with protons produced in the large accelerators. Prof. Peierls gave the concluding lecture, in which he summed up the earlier discussions and described some of the difficult unsolved problems connected with the heavier mesons and the hyperons. He referred—perhaps a little wistfully—to the period in the 'thirties when it was believed that an understanding of the dimensionless constant $e^2/\hbar c$ was just around the corner, and that with this understanding all problems of fundamental particles and nuclear forces would be solved . whereas to-day people don't know where to stop

The Physical Society and the organizers made the conference open without fee to all who were interested. Probably about half those present were Fellows or student members of the Society and rather more than half were visitors to Birmingham The total attendance was 135 Among this large number, there must have been a few whose background knowledge was insufficient, but the interest and enthusiasm of the meeting was maintained throughout, the audience at the last lecture was not noticeably less than that at the first Inquiries revealed a general feeling that an additional day or half-day to give time to assimilate the material would have been useful, but this statement was repeatedly accompanied by expressions of admiration for the excellence of the lectures It was possible to treat so much material in a short time only because very great care had been taken to devise a treatment which avoided all purely mathematical difficulties while revealing the essential unsolved problems of physical understanding

In concluding this report, it is reasonable to ask whether this meeting should form an example for some future meetings of the Physical Society If specialists in some other fields are prepared to give as much thought to the problems involved in explaining their work to other physicists, then they may also succeed, for example, a similar treatment of problems of supersonic flow might be very interesting Other scientific societies may also find occasional meetings of this type acceptable to their members

R W DITCHBURN

THE GEOGRAPHICAL ASSOCIATION

THE annual conference of the Geographical Association held at the London School of Economics during January 4–7 concluded a further eventful year in the life of the Association, although the year's activities were sadly clouded by the death of Dr O. J R Howarth, the immediate past-president, and also of Sir John Myres, a trustee, past-president and very staunch friend of the Association

A very successful spring conference was held amid delightful surroundings at Exeter, and the summer school, under the leadership of Mr R C Honeybone and Dr K A Sinnhuber, embarked on a new venture by meeting at Sistrans, near Innsbruck A second party of members also attended in August the International Conference of Teachers of Geography held at Hilversum As an outcome of this meeting the Geographical Association's office was adopted as the headquarters for the International Union of Associations of Teachers of Geography As the central co-ordinating body, the Association has now assumed responsibility for the development and exchange of ideas among teachers of geography throughout the world The Association has also sponsored courses for teachers in co-operation with the Norfolk Education Committee at Wymondham College, with the Derbyshire Education Committee at Buxton, with the Lancashire Education Committee at Manchester, and with Institutes of Education at London, Nottingham, Leeds and Reading

A lively branch activity continues, five new branches being formed during the year, thus bringing the total to forty-six, and the membership has risen accordingly and now approaches the four thousand mark The Association has watched with care the status of geography in the schools, and one important matter upon which questions were asked in the House of Commons was concerned with the changing regulations of the Scottish Universities Entrance Board Action was taken jointly with the Royal Geographical Society and the Institute of British Geographers in this instance At present considerable interest is focused upon the position of geography in secondary modern schools, comprehensive schools and technical schools

The three hundred and fifty teachers and lecturers who attended the annual conference were thus able to note with satisfaction a year of continuing vigorous activity under the presidency of Prof S W Wooldridge In a stimulating and provocative presidential address on the "Status of Geography and the Role of Field-work", Prof Wooldridge directed attention to the need for a closer liaison between university and school practitioners of the subject, and to the problem of achieving balance between the presentation of matter and methods of teaching in the training colleges The principles of field-work were enumerated and the need for local studies was emphasized, while the work of the Council for the Promotion of Field Studies was described together with the geographical facilities available at the four centres at Juniper Hall, Flatford Mill, Malham Tarn and Dale Fort.

The wide range of interests of the geographer was well illustrated by the supporting lectures Mr T. H Elkins spoke on Liège and the problems of southern Belgium, Mr D J Sinclair gave the results of a study in historical geography of some Surrey farms in the eighteenth and nineteenth centuries, Dr F. G Hannell lectured on the activities of the British Schools Exploring Society, and Mr R C Honeybone presented an account of the summer school's alpine field-studies

Educational aspects centred on a lecture by Mr Charles Armour (of the British Broadcasting Corporation) on school broadcasting and the teaching of geography, the talk being enlivened by recorded extracts from programmes and on three symposia arranged by section committees One dealt with problems of geography teaching and their relation to preparation for the university, a second discussed the General Certificate of Education of the Associated Examining Board, and a third—supported by a demonstration class—considered techniques of diagram and map-making in class A selection of recent geographical films was shown during the meeting, and Prof. P W Bryan once again contributed a 'Kodachrome' colour film, dealing on this occasion with the north-east Yorkshire moors, wolds and coast The customary publishers' exhibition of books, maps and appliances for the study and teaching of geography, supported by nearly forty publishers, was also arranged. The Association's Standing Committee for Visual Aids, in collaboration with the National Committee for Visual Aids in Education and the Educational Foundation for Visual Aids, also mounted an exhibition of visual aids and apparatus under the theme of "Ways of using Visual Aids in the Classroom".

Social activities at the conference included a summer schools reunion supper, a section luncheon, an Association tea, and the largest annual dinner yet held, at which Prof P W Bryan, Mr F Spencer Chapman and Mr Charles Armour were the guests On January 6 the Association met jointly with the Royal Geographical Society to hear Mr F. Spencer Chapman describe his "African Journey", and this terminated the more formal part of the conference On the last day, however, an interesting series of excursions had been arranged to places of geographical interest Conducted visits were paid to St Albans, Rothamsted Experimental Station, the Port of London, the Ordnance Survey and Messrs George Philips Map and Globe Works

The new year is entered upon with considerable changes among the officers of the Association. Mr T C. Warrington is now retiring after many years of service as honorary auditor and honorary librarian, and these two offices will in future be filled by Mr W. R A Ellis and Mr L J Jay Mr L S Suggate becomes president for 1955, while Mr R C Honeybone takes over from Prof W G V Balchin the post of honorary conference organizer Prof L Dudley Stamp, Prof E G Bowen and Prof W G V Balchin have been elected trustees of the Association

W G V Balchin

SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING AT NEWCASTLE UPON TYNE

MORE than four hundred science masters met in King's College, Newcastle upon Tyne, during the week between Christmas and New Year for the annual meeting of the Science Masters' Association The world-wide reach of the Association is shown by the fact that teachers were present from Ceylon, Nigeria, Uganda and Natal, also present were Mr Withers, secretary of the Education Section of the Federation of British Industries, Dr Dewar, representing Imperial Chemical Industries, Ltd, and Mr Obourn, an American observer from the Paris headquarters of Unesco

The first evening was the occasion of the presidential address by Dr C I C Bosanquet, rector of King's College This was delivered to a crowded audience in the large lecture theatre of the new Chemistry Building, remarkable for the excellence of its acoustics and of its air-conditioning system Dr Bosanquet's address was entitled "In Praise of Natural Philosophy" and was a plea for the broadening of the school curriculum for both the science and the arts specialists, the scientist, he said, is at present given a training only in a series of unrelated subjects, and the arts specialist is deprived of any further acquaintance with the great processes of Nature Dr Bosanquet quoted figures which showed that while the number of pupils taking science in schools is steadily rising, the number taking arts is almost stationary, and there is still a considerable proportion of boys in the public schools doing little or no science at all. As an example of the synthesis involved in the term 'natural philosophy', Dr Bosanquet dealt at some length with the life of Thomas Young, who was equally good at so great a variety of subjects Dr Bosanquet wants it to be possible for a student on reaching the university to change over from an arts course to a science one and vice versa He concluded by emphasizing the necessity for inculcating a sense of responsibility in the young scientist, he thought that wars are less likely to come from irresponsible rulers than from the apathy of those they rule, the young scientist should understand clearly that, in any future war, his chance of remaining unhurt is small

Among its many activities, the Association administers a trust fund for the presentation of a lecture on science and citizenship, usually given every second year This year the lecture was by Dr Eric James, High Master of Manchester Grammar School, and it will live long in the memories of those who heard it as a great occasion in the history of the Association, an excellent speaker giving out constructive thought at white heat in a splendid theatre to another crowded audience made it a remarkable experience Dr James took the view that the scientist cannot be a neutral technical expert, and must take full responsibility for the consequences of his work Even if that work be apparently without any practical application whatever, he still owes the opportunity to do that work to the social structure in which he lives, and he can therefore not afford to be indifferent to circumstances affecting that structure

Dr James expressed concern at the consequences of television, the "most politically significant invention since printing", since it creates masses of uncritical observers, and might prevent the heretic and the oddity, on whom progress depend, from having any public voice at all He thought also that as more and more of the best brains become involved in scientific pursuits, there is a grave risk that the level of ability in political administration may fall, and it is therefore essential that the scientist should have an education making him capable of taking over the work of government.

The more strictly scientific activities during the meeting included lectures by members of the science and applied science faculties of King's College Notable among these was one entitled "Demonstrations in Optics", by Prof W E Curtis, who is an outstanding example of that not too common combination, high ability as a scientist and great skill as a showman, all his very large number of experiments were most beautifully presented

On the same morning, Prof W F K Wynne-Jones gave a lecture on the presentation of physical ideas in chemistry, and Prof A D Hobson followed up a lecture on the marine fauna of the British Isles with an afternoon visit for members to the Marine Laboratory at Cullercoats

The second full day began with a lecture by Dr R McWeeny on the impact of quantum theory on the teaching of physics and chemistry, one by Prof T S Westoll on "Living Fossils", and one by Prof G S Rushbrooke on some characteristic features of twentieth-century physics Prof Westoll's lecture, on a semi-palæontological subject, marks a somewhat unusual departure for the Association, and indicates a steady broadening of its subject-matter •King's College has plans for a large new department of geology, in view of the importance of that study to the north-eastern area of Britain

The two main afternoons were occupied by visits to many different industrial organizations, such visits being indeed a strong point of the meeting, since the North East includes so many types of heavy and light industry. The sites visited included the Wilton and Billingham works of Imperial Chemical Industries, Ltd., the Pyrex glass works at Sunderland, two coal mines, factories making springs and pumps, works for gas, soap and mining machinery, the Ediswan lamp and valve factory, Parsons and Marine Engineering Turbine Research and Development Association, Reyrolles switchgear works, and the premises of Associated Lead Manufacturers, and of the Grubb Parsons Optical Co., Ltd. A visit was also made to the Radiochemical Laboratories at Durham, where accurate analyses of small quantities of rare gases are performed. Samples of gas from the upper atmosphere, taken in the United States by means of rockets, are sent to Durham for analysis.

The meeting also included discussions on M.K.S. units, on science teaching in secondary modern schools, and on science and religion.

The final morning again began with lectures, by Dr. S. L. Ranson on the metabolic activities of cellular particles, Dr. J. H. Wilkinson on small-scale organic preparations, and Mr. P. C. G. Isaac on public health engineering.

During the meeting, all the science and engineering laboratories of King's College were open, and members, manufacturers and publishers again gave their usual exhibitions; the manufacturers and publishers expressed great satisfaction at their excellent housing in the new Chemistry Building.

Special exhibitions were also arranged by the Northern Lighting Bureau of the Electric Lamp Manufacturers' Association and by the British Iron and Steel Federation. For the former, the area representative, Mr. R. J. Fothergill, had prepared a fascinating experimental display, including, in a corridor, an illuminated sign, the light from which detected whether one's shirt had been washed in particular detergents. For the Iron and Steel Federation, Capt. J. F. W. Mudford, area training organizer, had a comprehensive collection of all the Federation's educational literature, together with specimens and static models of its productions.

The social side of the meeting was catered for by an evening concert in King's Hall, preceded by a reception at which members and their ladies were welcomed by the Lord Mayor and Lady Mayoress of Newcastle upon Tyne, the Rector of King's College, and the Chairman of the Association and Mrs. Dyball. The playing in of the Lord Mayor by the Northumbrian pipes of Mr. Jack Armstrong was a touch characteristic of the locality, and the concert, which included piano solos by Miss Margaret Evans, Northumbrian songs by Mr. William Robinson, and pipe music by Mr. Armstrong, was much appreciated.

The Association is deeply indebted to all those who helped with the preparation of the meeting, and especially to the registrar, Mr. G. R. Hanson, to Prof. W. F. Cassie, who arranged the tours of the engineering laboratories; and to Dr. Chalmers Burns, director of music, who obtained the artistes for the concert.

It may be permissible to quote the final comment of a witty member from a famous Scottish public school, who said that he was going home "a wider and a humbler man, wider in that he had been fed so well, and humbler in that he had learnt so much".

W. H. DOWLAND

THE BRITISH FLORA DURING 1954

THE flora of the British Isles has been the subject of such thorough investigation, as compared with most other countries, that advances in knowledge can now be expected mainly from the application of new techniques and from the closer study of small groups. These were the approaches adopted by most of the exhibitors at the annual exhibition meeting of the Botanical Society of the British Isles, arranged in the lecture room of the British Museum (Natural History) on November 28. It was evident that cytology and careful analysis of variation are still yielding some of the most interesting results, and that the study of hybrids is proving of far greater importance than was supposed a few years ago.

One entirely new development was illustrated by H. J. M. Bowen (Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell). By means of activation analysis—the ashes being irradiated with neutrons in the Harwell pile, and the radioactive strontium then separated from all the other elements by conventional methods—he has determined the amount of strontium present in material from about forty species of plants. He finds that plants growing on ordinary soils contain 1–50 parts per million of strontium, but in the limited areas in Britain where the soils contain large concentrations of this element (as the sulphate, celestite; or as the carbonate, strontianite), plants are found to contain up to 2 per cent or more of strontium by dry weight. All the species examined were found to be accumulators. The Avon Gorge is one of the areas where considerable concentrations occur in the rocks, and the concentrations in some of the rare species found there (for example, *Arabis stricta* 1·06 per cent, *Anisantha madritensis* 1·16 per cent) are also high. Further investigation may show that the distribution of certain plants may be related to concentrations of strontium.

A number of very interesting hybrid grasses were exhibited. Dr. A. Melderis (British Museum (Natural History)) showed *Festuca rubra* × *Vulpia membranacea*, which was collected by several members on the Society's field meeting at Southport, and later by Miss M. McCallum Webster on dunes at Sandwich. In both places it evidently occurred in some quantity. A similar hybrid was exhibited by C. E. Hubbard (Royal Botanic Gardens, Kew) from Vazon, Guernsey. He also showed *Agrostis stolonifera* × *A. semiverticillata* from Vazon, *Festuca arundinacea* × *Lolium perenne*, and a variegated form of *Poa annua* from a shrubbery at Kew. With N. Y. Sandwith (Royal Botanic Gardens, Kew) he exhibited *Agropyron repens* × *Hordeum secalinum* (× *Agrohordeum langei*), collected by Mrs. C. I. Sandwith in 1945 from Shirehampton.

Two other hybrids exhibited which are new to the British list were *Carex binervis* × *C. punctata* from rocks near Barmouth, shown by P. M. Benoit, and *Mentha aquatica* × *M. rotundifolia* (*M.* × *maximiliana*), collected by Miss B. M. Sturdy near Penzance, and shown by R. Graham. J. D. Lovis (University of Leeds) provided an interesting demonstration of ferns. *Asplenium adulterinum* is a tetraploid species ($2n = 144$), intermediate in morphology between *A. viride* and *A. trichomanes*, and is found on serpentine rocks in central Europe and Fenno-Scandinavia, where it usually grows with one or

Applied Geophysics

A S EVE & D A. KEYS

This standard text-book first appeared in 1928 The fourth edition has been revised by Professor Keys to take account of recent developments. 40*s. net*

Actions of Radiations on Living Cells

D E LEA

The second edition, revised by L H. GRAY, of what *Nature* described as 'the most important and authoritative work now available' dealing with the action of ionizing radiations on living cells 30*s. net*

Petrology for Students

A HARKER

'Harker' was first published in 1895 The seventh edition of 1935 has for some time been out of print This eighth edition has been thoroughly revised by C E TILLEY, S. R NOCKOLDS and M BLACK. 18*s net*

CAMBRIDGE UNIVERSITY PRESS

Just Published—

HIGH-ENERGY ACCELERATORS

by

M STANLEY LIVINGSTON
Massachusetts Institute of Technology

(Interscience Tracts on Physics and Astronomy, Volume II)

CONTENTS High-Energy Accelerators as Tools for Nuclear Research Principles of Acceleration to High Energies The Electron Synchrotron The Synchrocyclotron Linear Accelerators The Proton Synchrotron Alternating Gradient Focusing References Index

1954 5 × 8 165 pages, with many diagrams 26/-

Published by the New York University Press—Distributed by Interscience Publishers

EXISTENCE THEOREMS FOR ORDINARY DIFFERENTIAL EQUATIONS

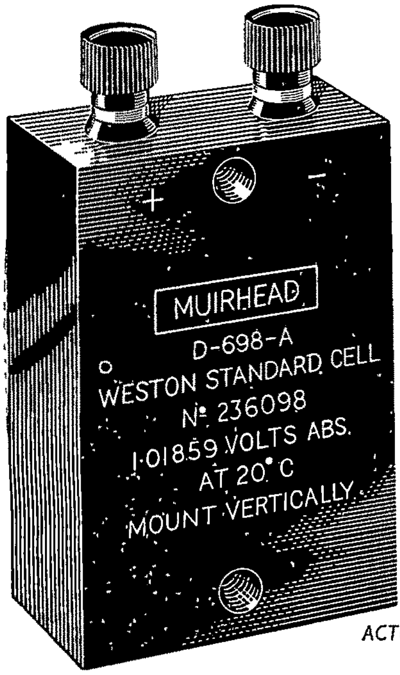
by

FRANCIS J MURRAY, Ph D
Prof of Mathematics, Columbia University
and
KENNETH S MILLER, Ph D
Assoc Prof of Mathematics, New York University

CONTENTS Introduction The Fundamental Existence Theorems General Existence Theorems Uniqueness Theorems The Picard Iterants Properties of Solutions Linear Differential Equations Index

1954 6 × 9 164 pages, with diagrams 40/-

INTERSCIENCE PUBLISHERS LTD.
88-90 CHANCERY LANE, LONDON, W.C.2



ACTUAL SIZE

A New Standard Cell by MUIRHEAD

£3.0.0

Post free in U K.

D-698 WESTON STANDARD CELL

This new cell combines the robustness and small size of our D-550 Miniature Standard Cell with a high capacity previously only obtainable in larger and more expensive types such as our D-402.

Whether you require a standard of E M F. for an industrial application or for laboratory use, this new cell will meet your needs and give many years of reliable service

SPECIFICATION

E.M F	1·01859V + 110μV − 90μV at 20°C.
Temperature coefficient	−0·00004 per °C.
Discharge rate	Up to 20μA for short periods
Internal resistance	600 ohms
Overall dimensions	$1\frac{15}{16}''$ x $1''$ x $3\frac{3}{8}''$
Weight	4 oz

Our D-550-A and D-402 Weston Standard Cells are still available

MUIRHEAD

PRECISION ELECTRICAL INSTRUMENTS

WRITE UNDER YOUR BUSINESS
LETTERHEAD FOR
PUBLICATION 5716

138

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

MACMILLAN BOOKS

Advanced Level Examples in Physics

R V JOHNS, M A , B Sc

Lecturer in Physics and Mathematics, City of Liverpool College of Technology

W F WARE, B Sc , A Inst P

Senior Physics Master, Cathays High School for Boys, Cardiff

This book of numerical examples is designed to supplement the theoretical and laboratory work of students preparing for examinations in Physics at the Advanced level of the General Certificate of Education and for Intermediate Degree examinations Some 1,000 examples have been arranged by topics and carefully graded in difficulty Contents are arranged under the headings Mechanics and Properties of Matter, Heat, Light, Sound, and Magnetism and Electricity 16*s*

A Text-book of Electricity and Magnetism

E R NOAKES, M A , F Inst P

This is the new, Third Edition of a book which will meet the need of those taking Intermediate degree courses and the Advanced and Scholarship Examinations of the General Certificate of Education All the usual topics required at this stage are dealt with, and where necessary calculus is used Among the special topics discussed are the conduction of electricity through gases, atomic physics and modern views on ferro- and terrestrial magnetism *Third Edition* 14*s*

Science and its Background

H D ANTHONY, M A (Cantab), B Sc , Ph D (Lond), F R A S

Here is the story of science, with the background of history in which that story is set Although most of the chapters centre around individual men of science whose work is of value to day, the historical background is not only that of isolated biography but the continuous history of human affairs Two chapters, on post-war developments and the pursuit of science for its own sake, have been added for this second edition *Second Edition* 20*s*

Comprehensive Inorganic Chemistry

Edited by M CANNON SNEED, J LEWIS MAYNARD and ROBERT C BRASTED

Volume III—The Halogens, by ROBERT C BRASTED

Comprehensive Inorganic Chemistry is an eleven-volume reference work on the chemical elements and their inorganic compounds In this Third Volume the significant advances of recent years are fully reflected in a broad treatment of halogen chemistry Both basic principles and their applications are exhaustively covered, as well as the new processes, methods of production, and the chemistry of compounds which have lately become so important 35*s*

All prices are net

St. Martin's Street, London, W.C.2

New Books

MAN IN A COLD ENVIRONMENT

By A C. BURTON, Ph D , and O G. EDHOLM

284 *pages*, 75 *illustrations* 30*s net*

This monograph provides a scientific study of the effect of low temperature on man

DEVELOPMENT OF TROPICAL AND SUB-TROPICAL COUNTRIES

With special reference to Africa

Edited by A LESLIE BANKS

234 *pages, illustrated* 18*s net*

A full discussion by a number of experts on the development of tropical countries, particularly agriculture, health and nutrition, and technological development

ANIMAL LIFE IN DESERTS

A Study of the Fauna in Relation to the Environment

By P A BUXTON, F R S

192 *pages*, 43 *illustrations* 21*s net*

This fascinating study of desert creatures and their surroundings is being re-issued in response to numerous requests

---

SCIENCE PROGRESS

A Quarterly Review of Scientific Work, Thought and Affairs

January, 1955

Recent Developments in Human Genetics By Prof L S Penrose, F R S

Recent Progress in the Theory of the Main Geomagnetic Field By S K Runcorn, Ph D

Atomic Sizes and Bond Types in their Relation to the Periodic System and to the Structure of the Atom By S I Tomkeieff, F G S

The Secondary Succession in the Tropical Rain Forest By Prof P W Richards

Recent Advances in Science Notes

Essay Review Book Reviews

Price 10*s* 6*d per copy Annual Postal Subscription* 43*s* 4*d net*

EDWARD ARNOLD (PUBLISHERS) LTD.
41 MADDOX STREET, LONDON, W 1

WANTED TO PURCHASE

Scientific books & periodicals

Entire libraries, and smaller collections ; sets and runs, foreign and domestic.

WALTER J. JOHNSON, INC.
125 East 23 Street, New York, 10, N Y., U.S.A.
Cable Address BOOKJOHNS, NEW YORK
British Office: ACADEMIC BOOKS, LTD.
129 Queensway, London, W.2

Scientific Circulations Ltd.

We have extensive stocks of Technical Journals, Periodicals and Textbooks Special terms for Technical and Commercial Libraries All Scientific and Technical publications purchased

111, Eastbourne Mews, London, W.2
Telephone AMBassador 6934

FARADAY'S ENCYCLOPEDIA
of HYDROCARBON COMPOUNDS

contains all known Hydrocarbons up to $C_{14}H_{16}$ in 13 up-to-date loose leaf volumes at under £10 per annum Less than a week's salary for a research worker Can save 95% of his time and bring results weeks earlier A research essential

CHEMINDEX LTD., 76 Cross Street, Manchester 2

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to all Leading Universities, Public Libraries and Institutions of the World
Catalogues issued

SELLING?

Specialists in Scientific, Technical Books and Publications of all Learned Societies.

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephone Wel 7948, *Amb* 5991

OPTICAL FLATS & PROOF PLATES

Your requirements may be listed in our Lens and Prism Leaflet but, if not, we would be glad to quote for making to specification

Our illustrated leaflets are available on request Listed are many Second-Hand and Ex-Government items of Photographic, Optical and Scientific interest

CHARLES FRANK

Instrument Makers and Dealers since 1907

67/73, SALTMARKET, GLASGOW, C.I

Phone Bell 2106 and 2107

THE MUSEUM BOOK STORE, LTD.

25 Devonshire St., London, W.I

(Welbeck 1340)

Buy and sell Scientific Journals and Periodicals and Learned Society Publications, in all languages Librarians, and others, should send us their list of "wants", or duplicates for sale *Binding undertaken*

◀ ◀ ◀ ◀ **GRATICULES**

We are now using so many modern methods of processing scales, masks and other graticules on glass that we can find a solution to most glass engraving and printing problems

PATON HAWKSLEY

ROCKHILL LABORATORIES, KEYNSHAM, SOMERSET

Offices 389 Archway Rd , London, N 6 KEYNSHAM 2364

HEFFER'S

for

Books on the Sciences

and the Humanities

English, American and

European

New and Secondhand

*

W. HEFFER & SONS LIMITED

Petty Cury Cambridge

BASIC NAVAL ARCHITECTURE

K C BARNABY, O B E , B Sc , M I N A

(Second edition, revised and largely rewritten)

Now accepted as the standard work on naval architecture to serve as a comprehensive instruction to the whole subject Illustrated 35/–

BUILDING SPECIFICATIONS

T SUMNER SMITH, F S I , F I ARB

(Second edition, revised)

"A valuable textbook which takes the reader through every item of building work in its proper order "—*Master Builder* Illustrated 16/–

DICTIONARY OF PLASTICS

PAUL I SMITH

"A valuable supplementary to the published works on plastics "—*The Engineer* 15/-

DRY ROT AND OTHER TIMBER TROUBLES

W P K FINDLAY, D Sc

"Should find its place on the bookshelves of all who handle and use timber"—*Timber Technology* Illustrated 25/–

FROM ATOMS TO STARS

MARTIN DAVIDSON, D Sc , F R A S

(Third edition, revised and enlarged)

"The book is up to date and can be strongly recommended "—Sir H Spencer Jones, F R S (Astronomer Royal), in *Endeavour.* Illustrated 18/–

THE GRADUATE IN INDUSTRY

P DUNSHEATH, C B E , M A (CANTAB), D Sc (ENG), M Inst C E

(Past President of the Institution of Electrical Engineers)

(Second edition)

"Valuable information is given about possible openings in personnel and education work in industry"—*Engineering* 10/6

WAVES AND TIDES

R C H RUSSELL, M A , and Cdr D H MACMILLAN, R N R (retd)

(Second edition, revised)

"Theories and observations are admirably illustrated"—*The Navy* Illustrated 25/–

HUTCHINSON'S

Scientific and Technical Publications

11 Stratford Place, London, W 1

RECENT SCIENTIFIC and TECHNICAL BOOKS

Volumes marked with an asterisk (*) have been received at "Nature" Office

Mathematics

BOAS, Jr, Ralph Philip Entire Functions (Pure and Applied Mathematics a Series of Monographs and Textbooks) Med 8vo Pp xi+276 (New York Academic Press, Inc, London Academic Books, Ltd, 1954) 6 dollars *

DEQUOY, N Mécanique à l'Usage de la Classe de Mathématiques Élémentaires (Traité de Physique Théorique et de Physique Mathématique —4) Super Royal 8vo Pp xii+200 (Paris Gauthier-Villars, 1954) 950 francs *

KAPLANSKY, Irving Infinite Abelian Groups (University of Michigan Publications in Mathematics—No 2) Med 8vo Pp v+91 (Ann Arbor University of Michigan Press, London Oxford University Press, 1954) 16*s* net *

SAVAGE, Leonard J The Foundations of Statistics (Wiley Publications in Statistics) Med 8vo Pp xv+294 (New York John Wiley and Sons, Inc London Chapman and Hall, Ltd, 1954) 48*s* net *

SOROKA, Walter W Analog Methods in Computation and Simulation, Med 8vo Pp xiii+390 (London McGraw-Hill Publishing Company, Ltd, 1954) 53*s* 6*d* *

Physics

GUMPRECHT, R O, and SLIEPCEVICH, C M Tables of Light-Scattering Functions of Spherical Particles Demy 8vo Pp 590 (Ann Arbor University of Michigan Press, London Oxford University Press, 1954) 52*s* net

NAKAYA, Ukichiro Snow Crystals Natural and Artificial Cr 4to Pp xii+510 (188 plates) (Cambridge, Mass Harvard University Press, London Oxford University Press, 1954) 80*s* net *

OLDENBERG, Otto Introduction to Atomic Physics Second edition Med 8vo Pp xiii+421 (London McGraw-Hill Publishing Company, Ltd, 1954) 48*s* *

RIDENOUR, Louis N Modern Physics for the Engineer Med 8vo Pp xix+499 London McGraw-Hill Publishing Company, Ltd, 1954) 53*s* 6*d* *

SOMMERFELD, Arnold Optics (Lectures on Theoretical Physics, Volume 4) Translated by Otto Laporte and Peter A Moldauer Med 8vo Pp xiii+383 (New York Academic Press, Inc, London Academic Books, Ltd, 1954) 6 80 dollars *

ter HAAR D Elements of Statistical Mechanics Med 8vo Pp xix+468 (New York Rinehart and Company, Inc, London Constable and Co, Ltd, 1954) 45*s* net *

Engineering

BANNER, E H W Electronic Measuring Instruments Med 8vo Pp xiv+395 (London Chapman and Hall, Ltd, 1954) 45*s* net *

KOTSCHIN, N J, KIBEL, I A, und ROSE, N W Theoretische Hydromechanik Band I Super Royal 8vo Pp xi+508 (Berlin Akademie-Verlag, 1954) 36 D marks *

LEVENS, A S Graphics in Engineering and Science 9½″×6½″ Pp 696 (New York John Wiley and Sons, Inc London Chapman and Hall, Ltd, 1954) 56*s* net

LYON, W V Transient Analysis of Alternating Current Machinery an Application of the Method of Symmetrical Components Med 8vo Pp 310 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 56*s* net

OSGOOD, W R (edited by) Residual Stresses in Metals and Metal Construction Med 8vo Pp 363 (New York Reinhold Publishing Corporation, London Chapman and Hall, Ltd, 1954) 80*s* net

POPE, Alan Wind-Tunnel Testing Second edition Demy 8vo Pp xv+511 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 68*s* net *

POWELL, Sheppard T Water Conditioning for Industry Med 8vo Pp x+548 (London McGraw-Hill Publishing Company, Ltd, 1954) 64*s* *

VER PLANCK, D W, and TEARE, B R Engineering Analysis an Introduction to Professional Method Med 8vo Pp 344 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 48*s* net

von KÁRMÁN, Theodore Aerodynamics Selected Topics in the Light of Their Historical Development Med 8vo Pp x+203 (Ithaca, N Y Cornell University Press, London Oxford University Press, 1954) 38*s* net *

Chemistry Chemical Industry

ANGUS, L H Physical Chemistry (Advanced and Scholarship Levels) Demy 8vo Pp viii+392 (London University Tutorial Press, Ltd, 1954) 15*s* *

APPLEYARD, F N, and LYONS, C G Practical Pharmaceutical Chemistry Eighth edition Cr 8vo Pp 192 (London Sir Isaac Pitman and Sons, Ltd, 1954) 15*s* net

BELCHER, R, and GODBERT, A L Semi-micro Quantitative Organic Analysis Second, revised edition Demy 8vo Pp 222 (London Longmans, Green and Co, Ltd, 1954) 21*s* net

CHERONIS, Nicholas D With contributions by RONZIO, A R, and MA, T S Micro and Semimicro Methods (Technique of Organic Chemistry —Vol 6) Med 8vo Pp xxiii+628 (New York Interscience Publishers, Inc, London Interscience Publishers, Ltd, 1954) 12 dollars *

PERRY, John H (edited by) Chemical Business Handbook (McGraw-Hill Series in Chemical Engineering) Cr 4to Pp xiii+1328+31 (London McGraw-Hill Publishing Company, Ltd, 1954) 120*s* *

ROLLEFSON, G K (edited by), POWELL, R E (in association with) Annual Review of Physical Chemistry Volume 5, 1954 Med 8vo Pp x+540 (Stanford, Calif Annual Reviews, Inc, 1954) 7 dollars *

SPRINGALL, H D The Structural Chemistry of Proteins Demy 8vo Pp x+376 (London Butterworths Scientific Publications, New York Academic Press, Inc, 1954) 45*s* net *

Technology

ANDERSEN, A J C Margarine Royal 8vo Pp viii+327 (London Pergamon Press, Ltd, 1954) 63*s* net *

DAVIES, C N Dust is Dangerous Demy 8vo Pp xviii+116+30 plates (London Faber and Faber, Ltd, 1954) 21*s* net *

DENNIS, W H Metallurgy of the Non-Ferrous Metals Demy 8vo Pp xii+647 (London Sir Isaac Pitman and Sons, Ltd, 1954) 70*s* net

MORGAN, P (edited by) Glass Reinforced Plastics Royal 8vo Pp 256 (London Iliffe and Sons, Ltd, 1954) 35*s* net

PARKER, Milton E, with the collaboration of HARVEY, Ellery H, and the late STATELER, E S Elements of Food Engineering Volume 2 Unit Operations—1 Pp vi+360 68*s* net Volume 3 Unit Operations —2 Pp vi+241 54*s* net (New York Reinhold Publishing Corporation, London Chapman and Hall, Ltd, 1954)*

VAUGHAN, N B (edited by) Metallurgical Abstracts General and Non-Ferrous Volume 20, 1952–53 (New Series) Demy 4to Pp iv+602 (London Institute of Metals, 1953) 60*s* *

Astronomy

ABETTI, Giorgio The History of Astronomy (Translated from the Italian "Storia dell' Astronomia", by Betty Burr Abetti) Demy 8vo Pp xviii+345+34 plates (London Sidgwick and Jackson, Ltd, 1954) 25*s* net *

AMERICAN EPHEMERIS and Nautical Almanac for the year 1956 Super Royal 8vo Pp xvii+644 (Washington, D C Government Printing Office, 1954) 4 dollars *

BUEDELER, Werner To Other Worlds Telescopes, Rockets, Stars Translated by A L Helm 9″ × 7″ Pp x+224 (London Burke Publishing Company, Ltd, 1954) 18*s*

OOSTERHOFF, P Th (edited by) Transactions of the International Astronomical Union Vol 8 Eighth General Assembly held at Rome, 4 September to 13 September 1952 (International Council of Scientific Unions International Astronomical Union) Cr 4to Pp ix+887 (Cambridge At the University Press, 1954) 63*s* net *

Geology Mineralogy

HOBSON G D Some Fundamentals of Petroleum Geology Demy 8vo Pp x—139 (London Oxford University Press, 1954) 18*s* net *

KIRKALDY, J F General Principles of Geology Med 8vo Pp 327+6 plates (London Hutchinson's Scientific and Technical Publications, 1954) 25*s* net *

LEVORSEN, A I Geology of Petroleum (A Series of Geology Texts) Med 8vo Pp x+703 (San Francisco W H Freeman and Company, London Bailey Bros and Swinfen, Ltd, 1954) 8 dollars, 68*s* *

RANKAMA, Kalervo Isotope Geology Super Royal 8vo Pp xvi+535+4 plates (London Pergamon Press, Ltd, New York McGraw-Hill Book Company, Inc, 1954) 75*s* net *

Geography Travel

ANDERSON, Margaret S (compiled by) Splendour of Earth an Anthology of Travel Demy 8vo Pp xxvi+404 (London George Philip and Son, Ltd, 1954) 25*s*

BROWN, Alec Yugoslavia Life and Landscape Med 8vo Pp 196 (London Elek Books, Ltd, 1954) 18*s*

HALEY, Frank Fifty Week-end Walks in the Lake District Cr 8vo Pp xi+115 (London Hodder and Stoughton, Ltd, 1954) 3*s* 6*d*

LeROY, M Land of the Niamoo Travels in the Forests of Equatorial Africa (Translated from the French by M A Michael) Med 8vo Pp 175 (London Arthur Barker, Ltd, 1954) 15*s*

MITCHELL, J B Historical Geography (Teach Yourself Geography Series) Cr 8vo Pp xvi+356 (London English Universities Press, Ltd, 1954) 10*s* 6*d* net *

SHACKLETON, M R Europe a Regional Geography Fifth revised edition Demy 8vo Pp 525 (London Longmans, Green and Co, Ltd, 1954) 27*s* 6*d* net

SIMPSON, Colin Adam with Arrows Inside New Guinea Royal 8vo Pp vii+240+24 plates (London and Sydney Angus and Robertson, Ltd, 1954) 21*s* *

General Biology Natural History Botany Zoology

AREY, Leslie Brainerd Developmental Anatomy a Textbook and Laboratory Manual of Embryology Sixth edition Super Royal 8vo Pp xi+680 (Philadelphia and London W B Saunders Company, 1954) 47*s* 6*d* *

ASBOE-HANSEN, G (edited by) Connective Tissue in Health and Disease Royal 8vo Pp 321+1 plate (Copenhagen Ejnar Munksgaard, 1954) 50 Danish kronor, 7 50 dollars *

BOURNE, G H, and DANIELLI, J F International Review of Cytology Volume 3 Med 8vo Pp x+530 (London Academic Books, Ltd, New York Academic Press, Inc, 1954) 9 50 dollars*

CLOUDSLEY-THOMPSON, J L (edited by) Biology of Deserts (The Proceedings of a Symposium on the Biology of Hot and Cold Deserts, organized by the Institute of Biology) 9½″ × 6½″ Pp iv+224 (London Institute of Biology, 1954) 14*s* *

GREENBLATT, Gordon M Cat Musculature 8″ × 9″ Pp 32 (Chicago University of Chicago Press, London Cambridge University Press, 1954) 7*s* 6*d* net *

HEBERER, Gerhard (herausgegeben von) Die Evolution der Organismen Ergebnisse und Probleme der Abstammungslehre Zweite erweiterte Auflage) Super Royal 8vo Pp iv+425–712 (Stuttgart Gustav Fischer Verlag, 1954) 20 20 D marks *

HEILBRUNN, L V, und WEBER, F (herausgegeben von) Protoplasmatologia Handbuch der Protoplasmaforschung Band 3, A 4 Chemistry and Physiology of Mitochondria and Microsomes By Olov Lindberg and Lars Ernster Super Royal 8vo Pp iii+136 58*s* Band 6, C Endomitose und Endomitotische Polyploidisierung Von Lothar Geitler Super Royal 8vo Pp iv+89 32*s* (Wien Springer-Verlag, 1953 and 1954)*

JOHNSON, M L, ABERCROMBIE, Michael, and FOGG, G E New Biology—No 17 Small Cr 8vo Pp 128+16 plates (Harmondsworth, Mddx Penguin Books, Ltd, 1954) 2*s* *

JOURNEES SCIENTIFIQUES de la Volaille et l'Oeuf 16, 17 et 18 Décembre 1953 (Les Journées Scientifiques du Centre National de Coordination des Études et Recherches sur la Nutrition et l'Alimentation—No 6) Med 8vo Pp vi+544 (Paris Centre National de la Recherche Scientifique, 1954) 1,650 francs *

KUDO, Richard R Protozoology Fourth edition Med 8vo Pp xi+966 (Springfield, Ill Charles C Thomas, Oxford Blackwell Scientific Publications, 1954) 77*s* 6*d* *

LACK, David The Natural Regulation of Animal Numbers Royal 8vo Pp viii+343 (Oxford Clarendon Press, London Oxford University Press, 1954) 35*s* net *

LAL, K N, and RAO, M S S Micro-Element Nutrition in Plants Royal 8vo Pp viii+246 (Banaras Banaras Hindu University Press, 1954) 20 rupees *

MARSHALL, A J Bower-Birds Their Displays and Breeding Cycles Royal 8vo Pp 218+26 plates (London Oxford University Press, 1954) 30*s* net *

TYRON, R M The Ferns and Fern Allies of Minnesota Demy 8vo Pp 186 (Minneapolis University of Minnesota Press, London Oxford University Press, 1954) 32*s* net

van LEEUWEN, W M D On the Biology of Some Javanese *Loranthaceae* and the Role Birds Play in Their Life History (Beaufortia—Series of Miscellaneous Publications Vol 4, No 41, October 20, 1954) Royal 8vo Pp ii+105–208+10 plates (Amsterdam Beaufortia, Zoological Museum, 1954) n p *

WIGGLESWORTH, V B The Physiology of Insect Metamorphosis (Cambridge Monographs in Experimental Biology—No 1) Demy 8vo Pp viii+152+4 plates (Cambridge At the University Press, 1954) 12*s* 6*d* *

Agriculture : Horticulture Forestry

CHAMPAGNAT, Paul The Pruning of Fruit Trees Edited and translated from the French by N B Bagenal) Demy 8vo Pp ix+166 (London Crosby Lockwood and Son, Ltd, 1954) 12*s* 6*d* *

DESCH, H E Manual of Malayan Timbers Volume 2 (Malayan Forest Records—No 15) Post 4to Pp ix+329–762+plates 70–127 (Singapore Malaya Publishing House, Ltd, 1954) 15 Malayan dollars *

HAINSWORTH, P H Agriculture a New Approach Demy 8vo Pp 248+24 plates (London Faber and Faber, Ltd, 1954) 21*s* net *

HENDERSON, Alexander, and HENDERSON, Elizabeth A Garden in the Suburbs Cr 8vo Pp 191 (London Cassel and Company, Ltd, 1954) 7*s* 6*d*

MARLOWE, Wilfred Eggs for Money (The Countryman Library) Cr 8vo Pp 111 (London Rupert Hart-Davis, Ltd, 1954) 7*s* 6*d*

Biochemistry . Physiology

BRITISH PHARMACEUTICAL CODEX, 1954 Med 8vo Pp xxxii+1340 (London The Pharmaceutical Press, 1954 Published by direction of the Council of the Pharmaceutical Society of Great Britain) 63*s* *

BURGER, Max Altern und Krankheit Grundlagen einer Biorheutischen Nosologie Zweite auflage Super Royal 8vo Pp xvi+600 (Leipzig Veb Georg Thieme, 1954) n p *

GREENBERG, David M Chemical Pathways of Metabolism Volume 2 Pp x+384 (New York Academic Press, Inc, London Academic Books, Ltd, 1954) 9 50 dollars *

HOFFBAUER, F W (edited by) Liver Injury, Transactions of the Twelfth Conference, September 21, 22 and 23, 1953 Med 8vo Pp 231 (New York Josiah Macy, Jr Foundation, 1954) 4 25 dollars *

PINCUS, Gregory (edited by) Recent Progress in Hormone Research The Proceedings of the Laurentian Hormone Conference Volume 10 Med 8vo Pp viii+511 (New York Academic Press, Inc, London Academic Books, Ltd, 1954) 9 80 dollars *

PUIG, P Los Hidro-Metabolitos y las "Enfermedades de la Civilizacion" 8½″ × 6¼″ Pp 325 (Barcelona Libreria Editorial Argos, S A, 1954) 100 pesetas *

ROTHMAN, S Physiology and Biochemistry of the Skin Royal 8vo Pp xiv+742 (Chicago University of Chicago Press, London Cambridge University Press, 1954) 146*s* 6*d* net

SEBRELL, W H, and HARRIS, Robert S (edited by) The Vitamins Chemistry, Physiology, Pathology Volume 2 Med 8vo Pp xiii+766 (New York Academic Press, Inc, London Academic Books, Ltd, 1954) 16 50 dollars *

VANNOTTI, A Porphyrins Their Biological and Chemical Importance (Translated by Prof C Rimington) Demy 8vo Pp ix+258+15 plates (London Hilger and Watts, Ltd, 1954) 50*s* net *

Anthropology . Archæology

CLARK, J D The Prehistoric Cultures of the Horn of Africa An Analysis of the Stone Age Cultural and Climatic Succession in the Somalilands and Eastern Parts of Abyssinia (Occasional Publications of the Cambridge University Museum of Archæology and Ethnology—Volume 2) Cr 4to Pp xx+386+52 plates (Cambridge At the University Press, 1954) 105*s* net *

CURWEN, E Cecil The Archæology of Sussex Second edition, revised La Post 8vo Pp xx+330+32 plates (London Methuen and Co, Ltd, 1954) 25*s* net *

GLUCKMAN, M Rituals of Rebellion in South-East Africa (Frazer Lecture for 1952) Demy 8vo Pp 36 (Manchester At the University Press, 1954) 3*s* 6*d*

VERRILL, A H, and VERRILL, Ruth America's Ancient Civilizations Second edition Demy 8vo Pp xvii+334 (London Putnam and Co, Ltd, 1954) 25*s*

Philosophy . Psychology

AYER, A J Philosophical Essays Med 8vo Pp xi+289 (London Macmillan and Co, Ltd, 1954) 18*s* net

BAGCHI, S Inductive Reasoning a Study of Tarka and its Role in Indian Logic Super Royal 8vo Pp xxix+312 (Calcutta Calcutta Oriental Press, 1954) 16 rupees

BRAATØY, Trygve Fundamentals of Psychoanalytic Technique (Wiley Publications in the Mental Health Sciences) Med 8vo Pp xi+404 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 48*s* net *

de FOREST, Izette The Leaven of Love a Development of the Psychoanalytic Theory and Technique of Sandor Ferenczi La Post 8vo Pp xvi+206 (London Victor Gollancz, Ltd, 1954) 15*s* net *

DESAN, W The Tragic Finale an Essay on the Philosophy of Jean-Paul Sartre Demy 8vo Pp 234 (Cambridge, Mass Harvard University Press, London Oxford University Press, 1954) 34*s* net

ERTEL, Hans Kausalitat, Teleologie und Willensfreiheit als Problemkomplex der Naturphilosophie (Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin Klasse fur Mathematik und allgemeine Naturwissenschaften, Jahrgang 1954, Nr 1) Demy 8vo Pp 29 (Berlin Akademie Verlag, 1954) 1 70 D marks *

EVANS, Jean Three Men an Experiment in the Biography of Emotion Large Post 8vo Pp xviii+297 (London Victor Gollancz, Ltd, 1954) 15*s* net *

EYSENCK, H J The Psychology of Politics 8vo Pp xvi+317 (London Routledge and Kegan Paul, Ltd, 1954) 35*s* net

FENICHEL, O The Collected Papers of Otto Fenichel Edited by Hanna Fenichel and David Rapaport Roy 8vo Pp xiv+408 (London Routledge and Kegan Paul, Ltd, 1954) 35*s* net

FIREMAN, Peter Perceptualistic Theory of Knowledge Ex Cr 8vo Pp xi+50 (New York Philosophical Library, 1954) 2 75 dollars *

FRUCHTER, Benjamin Introduction to Factor Analysis (The Van Nostrand Series in Psychology) Med 8vo Pp xii+280 (New York D Van Nostrand Company, Inc, London Macmillan and Co, Ltd, 1954) 37*s* 6*d* net *

GRYGIER, T Oppression a Study in Social and Criminal Psychology (International Library of Sociology and Social Reconstruction) Demy 8vo Pp xiv+362 (London Routledge and Kegan Paul, Ltd, 1954) 28*s*

LEWIS, J Introduction to Philosophy Demy 8vo Pp 248 (London C A Watts and Co, Ltd, 1954) 21*s* net

LINDGREN, Henry Clay How to Understand Yourself and Other People Demy 8vo Pp xii+223 (London Rider and Company, 1954) 12*s* 6*d* net *

STIERNOTTE, Alfred P God and Space-Time Deity in the Philosophy of Samuel Alexander Demy 8vo Pp xxvii+455 (New York Philosophical Library, 1954) 3 dollars *

von EICKSTEDT, Egon Freiherr Atom und Psyche Ein Deutungsversuch Demy 8vo Pp iii+158 (Stuttgart Ferdinand Enke Verlag, 1954) 14 20 D marks *

ZUBEK, John P, and SOLBERG, P A Human Development (McGraw-Hill Series in Psychology) Med 8vo Pp vii+476 (London McGraw-Hill Publishing Company, Ltd, 1954) 48*s* *

Miscellany

ANDRADE, E N da C Sir Isaac Newton (Brief Lives Series) Cr 8vo Pp 140 (London William Collins, Sons and Co, Ltd, 1954) 7*s* 6*d* net *

BERNAL, J D Science in History Demy 8vo Pp xxiv+967+4 plates (London C A Watts and Co, Ltd, 1954) 42*s* net *

de VRIES, Louis English–German Technical and Engineering Dictionary Med 8vo Pp xv+997 (London McGraw-Hill Publishing Company, Ltd, 1954) 140*s* *

GALVANI, Luigi Commentary on the Effects of Electricity on Muscular Motion (Translated into English by Margaret Glover Foley, with notes and a critical introduction by I Bernard Cohen) (Publication No 10) Demy 4to Pp 176 (Norwalk, Conn Burndy Library, 1953) n p *

GARDNER, Gerald B Witchcraft Today Demy 8vo Pp 163+4 plates (London Rider and Company, 1954) 12*s* 6*d* net *

GROSS, Feliks Foreign Policy Analysis Demy 8vo Pp xxiv+179 (New York Philosophical Library, 1954) 3 75 dollars *

HALL, A R The Scientific Revolution 1500–1800 The Formation of the Modern Scientific Attitude Med 8vo Pp xvii+390 (London Longmans, Green and Co, Ltd, 1954) 21*s* net *

LEWIS, Hilda Deprived Children the Mersham Experiment—a Social and Clinical Study Demy 8vo Pp xvii+163 (London Oxford University Press, 1954 Published for the Nuffield Foundation) 9*s* 6*d* net *

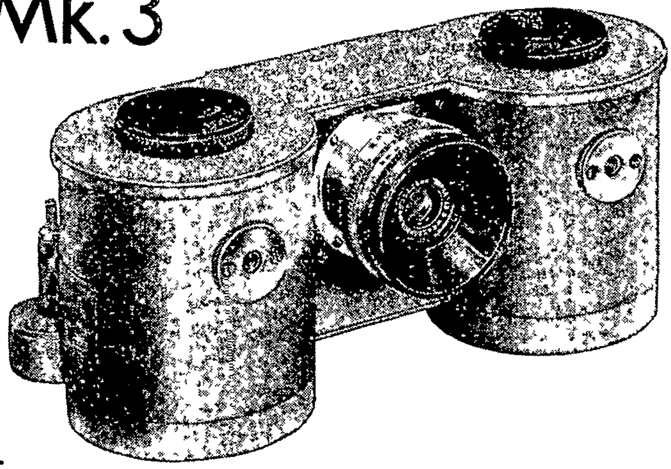
LORENZ, Konrad Z Man Meets Dog (Translated by Marjorie Kerr Wilson) Ex Cr 8vo Pp x+199 (London Methuen and Co, Ltd, 1954) 15*s* net *

MOULTON, H Fletcher, and LANGDON-DAVIES, P G The Law of Merchandise Marks, including the Merchandise Act, 1953 (Reprinted from Butterworths Annotated Legislation Service) Royal 8vo Pp 170 (London Butterworth and Co (Publishers), Ltd, 1954) 17*s* 6*d* net *

SHAPLEY, Harlow, RAPPORT, Samuel, and WRIGHT, Helen (edited by) A Treasury of Science Third revised edition, with new material on Electronics, Nuclear Physics and Contemporary Medicine, and a new section on Science and the Future Demy 8vo Pp xii+654 (London and Sydney Angus and Robertson, Ltd, 1954) 21*s* net *

The Auto Camera Mk. 3

A VERSATILE RECORDING INSTRUMENT

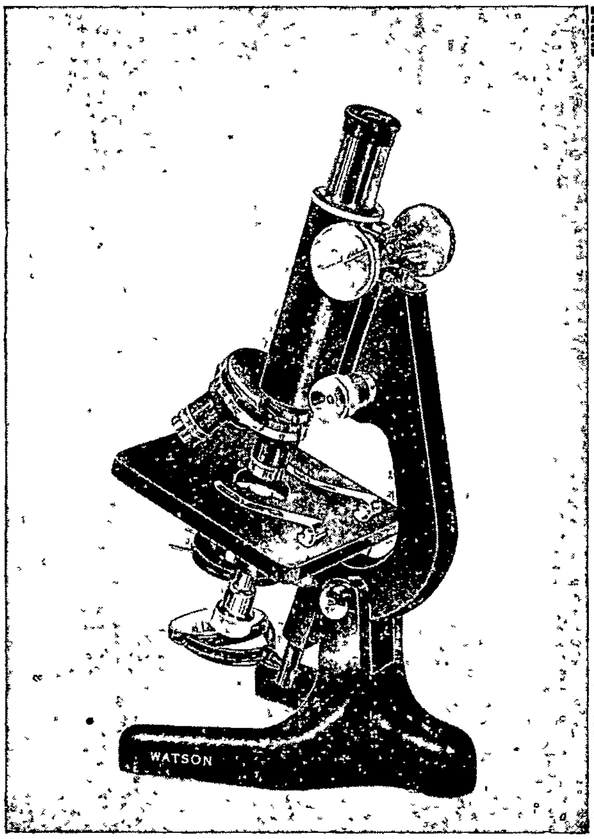


Specially designed to cover a wide field of industrial and scientific work where the rapid production of high quality microfilms is required It is eminently suitable for such purposes as instrument recording, photo-micrography, oscillograph records, process timing, document copying, etc It is fully automatic in its operation, the exposure and film transport being effected by a single electrical impulse operating on 12 or 24 volt d c Special daylight loading cassettes give a full 200 1″ × 1″ or 300 1″ × ¾″ exposures from one loading of 35 mm perforated film. The camera may also be controlled by manual operation

Write for 16-page illustrated brochure.

THE INSTRUMENT DIVISION OF

D. Shackman and Sons CHILTERN WORKS CHESHAM · BUCKS



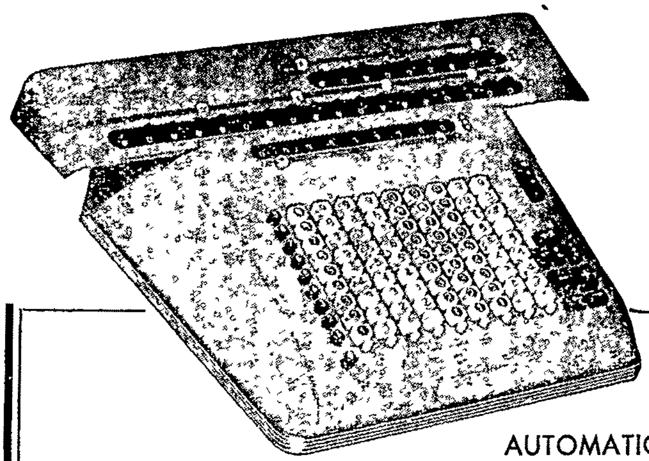
MICROSCOPES

The "Kima" Microscope illustrated is an example selected from the range of Watson Microscopes. This model is simple in design, but a robust instrument of precision. Will take standard size accessories and can be fitted with attachable mechanical stage.

Write for List,
4A "Kima" Microscope.

WATSON'S

W. WATSON & SONS LTD · 313, HIGH HOLBORN, LONDON, W.C.1.



*εὕρηκα!!

Is what you will say too

*EUREKA ! (I have found it)

Archimedes

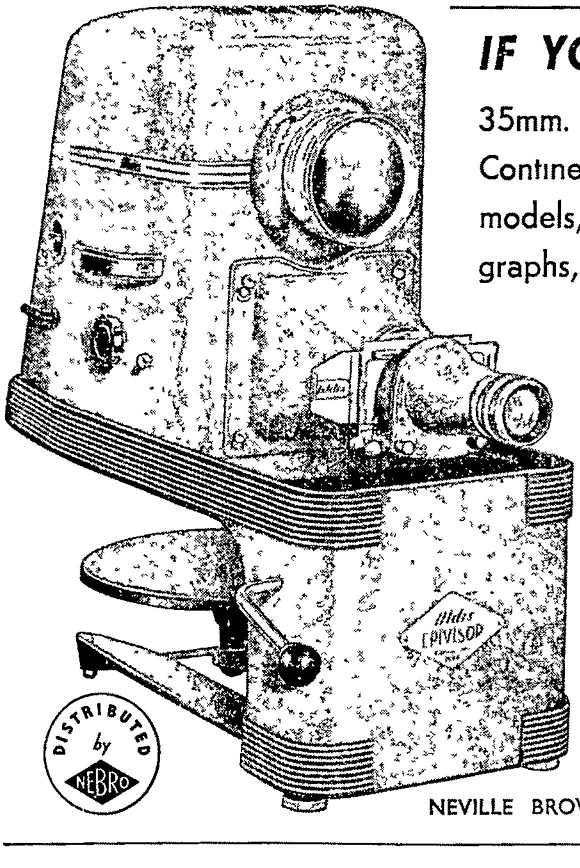
AUTOMATIC ADDING–CALCULATING MACHINE

SUPERMATIC
SHORT-CUTTING
MODEL
£190
Other Electric Models
from **£150**

Speed and Silence from exclusive Short-cut Multiplication

Operated without skill or training, robustness and reliability from 50 years' manufacturing experience. Automatic division, addition and subtraction

ARCHIMEDES-DIEHL-MACHINE COMPANY LIMITED
CHANDOS HOUSE, BUCKINGHAM GATE, LONDON, S W 1 ABBey 6397
Sales and Service in all principal centres



IF YOU WANT TO PROJECT

35mm. film strips, 2″x 2″ or 3¼″x 3¼″ slides, Continental slides, micro slides, specimens, models, drawings, blueprints, photographs, graphs, etc, etc. . .

THERE IS ONLY ONE ANSWER

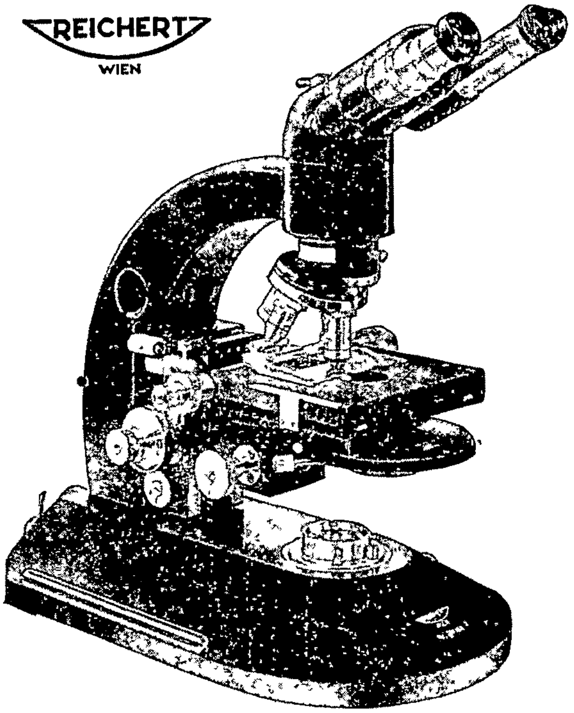
Aldis 'EPIVISOR'

(Registered Trade Mark)

EPIDIASCOPE

This versatile instrument enables you to project greatly enlarged and perfectly defined images of flat and solid objects, as well as film strips and slides It is indispensable in research and in training Full details will gladly be sent on request, together with the name of your nearest dealer, who will be pleased to demonstrate

Sole Wholesale Distributors
NEVILLE BROWN & CO LTD, 77 NEWMAN ST, LONDON, W 1



REICHERT NEOZET

well worth looking into

We have no hesitation in saying that this instrument represents the most important advance in routine microscopy for many years Here are some of its features

Automatic Coarse Focusing greatly speeds up routine high power microscopy and positively prevents damage to slides and lenses

Built-in Illumination with lever operated lamp condenser and field iris diaphragm for Koehler illumination

Novel Binocular Body with constant tube length and integral **magnification changer.**

Anoptral Contrast Equipment opens up new vistas in the examination of unstained specimens by greatly increased contrast combined with maximum resolution and freedom from reflections *

Polyphos Universal Condenser provides bright ground, phase- or anoptral contrast and dark ground illumination in continuous succession

We shall be pleased to send you further particulars of this remarkable microscope and to demonstrate it to you in our showroom

* The Anoptral Contrast Equipment is now available for fitting to your existing microscopes

SHANDON

SHANDON SCIENTIFIC COMPANY LTD.
6, CROMWELL PLACE, LONDON, S W 7 Tel KNI 1131

SINGER

Micromanipulators

Singer (High-power) Micromanipulators are suitable for use under magnifications of from × 100 to × 1,000 diameters *plus*, as described by Barer and Saunders-Singer in the *Quarterly Journal of Microscopical Science*, Vol 89, pp. 439-447, December, 1948.

Singer Microdissectors (Low-power Micromanipulators) are suitable for use under magnifications of from 1 to ×200 diameters and are described by Barer and Saunders-Singer in the *Journal of Scientific Instruments*, Vol 28, pp 65-68, March 1951

●

SINGER INSTRUMENT COMPANY LTD.
83, London Street, Reading

FOR pH CONTROL

JOHNSONS OF HENDON offer to chemists and manufacturers this useful series of five test papers for the measurement of pH values. UNIVERSAL is one paper covering completely the range from pH 1 to pH 10, enabling pH values to be checked to within 0 5 pH COMPARATOR test papers make a set of four separate indicators for obtaining still greater accuracy by determining the pH value of any solution to within 0 3 pH

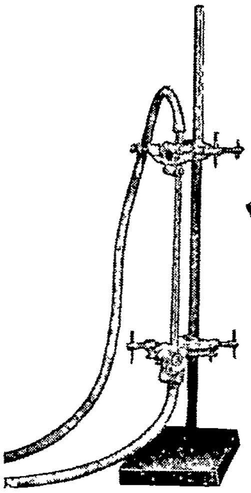
Descriptive leaflet will be sent free on request

JOHNSONS OF HENDON LTD.
LONDON, N W 4 ESTABLISHED 1743

Measuring

Rate of flow

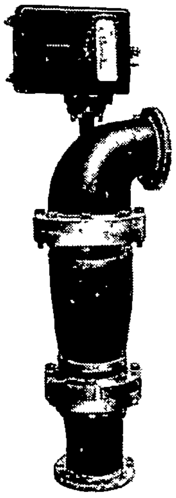
in research and industry



Type 100
Tube and float only, for laboratory use

FROM
Simple and accurate direct-reading Glass Tube Rotameters

TO
Complete flow control equipment employing air-operated valve, power cylinder or electric motor speed regulator



Type 472
Industrial Rotameter for 8 in pipe Transmitting unit provides air signal to controller

Write for Catalogue RP2000/N which gives full details of the Rotameter range of flowmeters

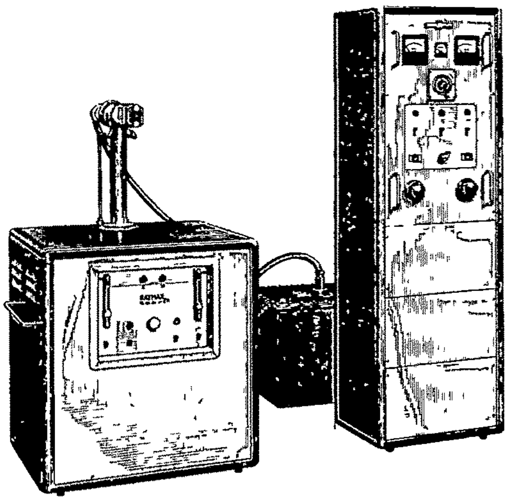
ROTAMETER

INSTRUMENTS FOR LIQUID AND GAS FLOW MEASUREMENT AND CONTROL

ROTAMETER MANUFACTURING COMPANY LIMITED
602 PURLEY WAY · CROYDON · SURREY
Telephone · CROydon 3816/9

DG/GI5

Minimum cost Maximum efficiency



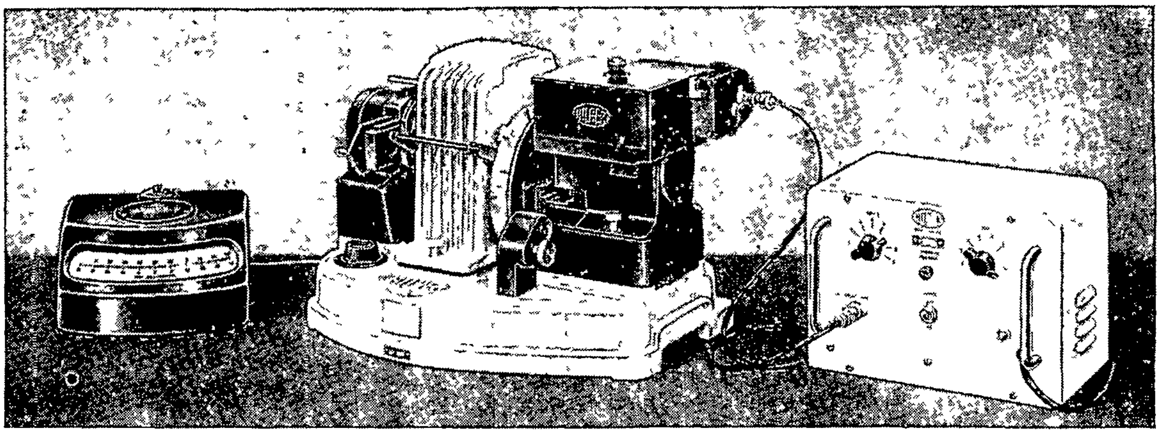
RAYMAX 60

X-RAY DIFFRACTION UNIT

The new RAYMAX 60 Unit, comprising a compact 3-piece assembly—occupying minimum space—incorporates a continuously evacuated x-ray tube with demountable target tips, windows and cathode assembly, providing at the minimum initial cost, diffraction facilities which can be extended, as required, for wider service and specialised techniques

Write or ring for further details

NEWTON VICTOR LTD
132 LONG ACRE, LONDON W C 2 COVENT GARDEN 0861
MEMBER OF THE A E I GROUP OF COMPANIES



New Spekker Fluorimeter

The increasing use of fluorescence methods for micro-analysis, for instance in the determination of anti-malarials excreted in the course of treatment, has rendered obsolete the earlier forms of fluorimeter which were capable of only relatively insensitive measurements.

The new Spekker Fluorimeter, while retaining its well-established optical principles, has been redesigned to meet the demand for an instrument providing the very high sensitivity and accuracy necessary for this type of work.

It is a compact instrument, simple to operate from A.C. mains. The balanced photoelectric system compensates for any fluctuations in intensity of the light source due to mains voltage variations, thus ensuring permanent accuracy of calibration.

The instrument can be readily converted to the well-known Spekker Absorptiometer; and parts can be supplied to owners of the Absorptiometer which will convert it to the new type Fluorimeter.

For full information please write for catalogue CH390 (N.1)

HILGER & WATTS LTD.
HILGER DIVISION
98 St. Pancras Way, Camden Road, London, N.W.1, England

Member of the Scientific Instrument Manufacturers' Association and of SCIEX

other of the species mentioned It may yet be found on serpentine rocks in the more remote parts of Scotland Investigation showed that it is amphidiploid, with the diploid form of *A. trichomanes* ($2n = 72$) and *A viride* ($2n = 72$) as its probable parents The hybrids *A. trichomanes* ($2x$) × *A adulterinum*, *A adulterinum* × *A trichomanes* and *A viride* × *A. adulterinum* have been synthesized *Asplenium* × *breynii*[1] was also exhibited.

Another aspect of the importance of the study of hybridity was demonstrated in the exhibit by Prof T G Tutin (University College, Leicester) of British material of *Symphytum.* The plant usually referred to as *S peregrinum*, which is frequent, and very variable, appears to be the central part of a hybrid swarm from the cross between *S officinale* and *S asperum* Dr. E F. Warburg (Department of Botany, University of Oxford), who has been re-examining material of alleged hybrids in connexion with work on the new "Plant List" which the Society has in preparation, exhibited herbarium specimens of some of the plants on which published names have been based He found that some of these 'hybrids' are morphologically convincing, but others, such as *Lotus* × *davyae* and *Potentilla* × *cryeri*, are apparently only forms of one of the alleged parents

The University of Manchester exhibit on *Senecio* covered an excellent example of a polyploid hybrid which is fertile, and this is to be described as a new species *Senecio squalidus* ($2n = 20$) was crossed with *S vulgaris* ($2n = 40$), and from the hybrid ($2n = 30$), by colchicine treatment, the synthetic polyploid ($2n = 60$) was produced. This was exhibited in three forms mid-ray, long-ray and rayless. The synthesized plant was found to agree in morphological characters with a natural polyploid found in North Wales by H E Green in 1948, which was seen wild in quantity again this year, and which has persisted in cultivation since its discovery A technique for growing species of *Euphrasia*[1], which are partially parasitic, was demonstrated last year by P F Yeo (University of Cambridge) This year he exhibited artificial hybrids of *Euphrasia occidentalis* with *E salisburgensis* var *hibernica* and with *E pseudokerneri*, which had been grown with their parents on *Medicago lupulina* as the standard host

In 1952, *Artemisia norvegica* was discovered in north-west Scotland[2] Critical examination by Prof E Hultén of the circumpolar group of closely related species to which this belongs has shown that the plant from Scotland is distinct, and it has been described as ssp *scotica*[3]. The type material on which the new taxon is based was exhibited by the Department of Botany, British Museum (Natural History). The Department also showed specimens of *Rubus arcticus* from its collection labelled as collected from Ben Lomond and "Ben-y-glo", for comparison with one from "Ben Lawers, 1837" recently detected in Cosmo Melville's herbarium in the Butler Museum, Harrow, by R M Harley This circumpolar species occurs in Scandinavia, and further search may well confirm it as a British plant The Museum also exhibited interesting sheets of *Carex lepidocarpa* ssp *scotica*[4], *Nuphar pumila* and *N. intermedia*[5], and viviparous grasses[6] to illustrated recent papers in *Watsonia.* P. S. Green (Royal Botanic Gardens, Edinburgh) showed seeds, specimens and a map of the distribution of *Stellaria nemorum* spp *glochidisperma*, which he has recently described for Britain[7].

Dr S. M. Walters (Botany School, University of Cambridge) demonstrated the use of the category 'sub-species' in taxonomy, pointing out that in current practice three different situations are involved, namely, the geographical sub-species, the "cyto-sub-species" and the "ignorance sub-species". He suggested that the use of the same category for genetically different situations is in no way either inconvenient or undesirable, and illustrated the point with reference to the diploid, tetraploid and hexaploid cytodemes of *Polypodium vulgare* L , for which he advocated a sub-specific category Dr. K B. Blackburn and Miss A W. Adams (King's College, Newcastle upon Tyne) provided an interesting exhibit of cytology of *Herniaria* In the *glabra* group of the sub-genus *Eu-herniaria* the chromosome numbers show a polyploid series on a base of nine. S Challenger (University of Bristol) exhibited flowers of *Dianthus gratianopolitanus* from Cheddar Gorge, which show a surprising amount of variation for a species with such a restricted distribution in Britain. Living plants, silhouettes of the fruit papillæ and distribution maps of *Galium pumilum* in Britain were shown by K M Goodway, who suggested that this could be tentatively divided into western ($2x$), montane (? hybrid), northern-limestone ($4x$), southern-chalk (? $8x$) and Cheddar (? $8x$) forms D. J Hambler (Queen Mary College, London) illustrated the cytology and ecology of Orobanchaceae and semi-parasitic members of the Scrophulariaceae[8], A C Jermy (University College, Leicester) showed variations in *Carex nigra* and its hybrids, and M C F. Proctor (Nature Conservancy) of *Helianthemum canum*

The main exhibit concerned with the distribution of British plants was that of the Society's distribution-maps scheme[9], on which three full-time and two part-time assistants are now engaged in addition to the director. The nine hundred 10-kilometre squares for which volunteers have already accepted responsibility for the contribution of records were indicated on a large map, and further offers were received during the exhibition Dr C D Pigott (University of Sheffield) provided an exhibit to illustrate the fact that many northern plants reach the south-eastern limits of their distribution, and many southern plants their north-western limits, along a line that runs diagonally across central England, and used *Asplenium viride* and *Cirsium acaule* as examples These meet but never overlap, and it is significant that near Sheffield the reproductive capacity of *C acaule* is greatly reduced There seems little doubt that this phytogeographical boundary is also a significant climatic boundary J E Lousley showed photographs of the very rare orchid *Epipogium aphyllum* from a new locality in Oxfordshire Dr T D V. Swinscow exhibited photographs of ferns at Leagrave Station, Bedfordshire, where nine species had been found They included both calcicole and calcifuge ferns, and their occurrence on a railway platform suggests that distribution of the spores may be facilitated by the traffic R A Graham provided evidence that *Cypripedium calceolus* occurred in Yorkshire in 1954 P M Benoit showed *Salicornia perennis* from Barmouth and Mochras, Merioneth, as the first certain records for Wales W. S. Lacey (University College of North Wales, Bangor) had an exhibit to illustrate his discovery of *Orchis traunsteineri* in Caernarvonshire. Sub-fossil botany was represented by an exhibit by J W Franks (University College, Leicester) of plants from the '*N*' horizon in the Esthwaite basin The drop in tree pollen, rise in grass pollen and occurrence of *Plantago lanceolata* suggest that this horizon may represent the beginnings of cultivation in the area.

A useful warning to modern collectors and commentators was implied in the exhibit by Mrs H N Clokie (Department of Botany, University of Oxford) of selected sheets from the Du Bois (1690–1723) and Sherardian (1700–26) herbaria These showed the confusion and loss of information which can result from illegible labels, or from mounting plants which could not be certainly associated with their labels The Library of the British Museum (Natural History) displayed a magnificent series of unpublished drawings prepared for Church's "Types of Floral Mechanism" and unpublished text The view was freely expressed that the publication of these fine additional drawings would be a valuable addition to the book already available

A full account of the exhibits will appear in due course in the *Proceedings* of the Society The meeting was attended by about two hundred and eighty members and guests J. E Lousley

[1] Lousley, J E, *Nature*, 173, 113 (1954)
[2] Lousley, J E, *Nature*, 171, 335 (1953)
[3] Hultén, E, *Nytt Mag Bot*, 3, 67 (1954)
[4] Davies, E, *Watsonia*, 3, 71 (1953)
[5] Heslop-Harrison, J, *Watsonia*, 3, 7 (1953)
[6] Wycherley, P R, *Watsonia*, 3, 41 (1953)
[7] Green, P S, *Watsonia*, 3, 122 (1954)
[8] Hambler, D J, *Nature*, 174, 838 (1954)
[9] Walters, S M, *Nature*, 173, 1079 (1954)

HYDRAULIC TRANSPORT OF COAL

TRANSPORT of coal from the mines to the user represents an appreciable proportion of the energy in the fuel Normally this is done by rail or sea transport, but transportation through pipes as a suspension in water is another possibility. The advantages of hydraulic transport over short distances within the workings of the colliery are apparent—either underground or on the surface, or even as an alternative to normal cage winding There is, however, the possibility that hydraulic transport of coal could be operated over much longer distances, this has already been accomplished up to five miles, and a hundred-mile pipe-line is planned in the Pittsburgh area These advantages and many others were described by Dr Idris Jones, director-general of research, National Coal Board, in an introductory address to a colloquium on "The Hydraulic Transport of Coal" held by the National Coal Board in London during November 5–6, 1952 (pp vi+75 London National Coal Board, 1954), which was opened by Sir Charles Ellis

Although there is in existence much experimental data on the transport of solid material by water streams in open channels and pipes, the numerous factors involved have hindered the formulation of any theory which will give a full understanding of the transport process in pipes The purpose of the colloquium was to assemble and compare such results as are available and to discuss tentative theories The first four papers dealt mainly with fundamental theory and the development of dimensionless groups characterizing the flow of suspensions through pipes, with lump sizes up to 4 in Some of the authors admitted that the present theory is inadequate, and it is evident that this is only the beginning of research on this subject The second group of four papers described the development of coal feeders and experimental installations in France and at Markham Colliery

The discussion on the papers is included in the publication, and the proceedings form a useful basis for further study of a subject which is becoming of increasing practical importance. H Heywood

RECENT WORK IN MAYAN ARCHÆOLOGY

OVER a long period of years, the Carnegie Institution, through its Archæological Department, has produced a most valuable series of publications, most of which deal with the Maya area The shorter studies in this series have appeared in volumes of *Contributions*, of which that under review is a useful example*

No 52, by Howel Williams, deals with some human and animal footprints first discovered seventy years ago on the outskirts of Managua, Nicaragua, which aroused a great deal of interest when they were found, owing to their supposedly great age This was based on the considerable depth of four metres at which they were found, and was estimated at 50,000 years or more Further examples were found at the same horizon in 1941, so it has been possible to study the question afresh Williams shows that the deposits in and under which they occur are pumices and mud-flows associated with vulcanicity, which must have been accumulated at a great rate, so that their age has been grossly exaggerated. The prints are abundant and may well have been made by people fleeing from a rain of ash from the volcano Masaya On the scanty evidence of a sheard of Usulutan ware found on the site at a considerably higher level, it is concluded that the footprints are between 3,000 and 5,000 years old The author holds out little hope of obtaining material for radiocarbon dating, so it is unlikely that this estimate can be improved on

The second paper, No 53, by A V. Kidder and E M Shook, describes the partial excavation of a complex temple mound containing at least two important burials at the Maya site of Kaminaljuyú, near Guatemala City The authors, with J D Jennings, have already published an important work on Kaminaljuyú, but it is a very large site and a great deal remains to be done This was largely a rescue dig, necessitated by the destruction of part of the mound by brick-making activities The mound proved to belong to the Miraflores phase of the Pre-Classic or Middle Culture Period, dating in all probability from the first part of the first millennium B C, the authors had suspected that this might be so, but had been loth, in the absence of positive proof, to ascribe so large and complex a structure to this early period The importance of the work lies mainly in the recognition of this fact, which may make it necessary to postulate the emergence of 'Classic' social structures, for example, a ruling class, in pre-Classic times, and perhaps to revise our chronological nomenclature accordingly

Something is known of the archæological record of the Maya in Northern Yucatan from the Formative

---

* Contributions to American Anthropology and History Vol 11, Nos 52–56 (Publication 596) Pp vi+236 (Washington, D C Carnegie Institution of Washington, 1954) 6 75 dollars, paper, 7 50 dollars, cloth

Period, before, say, the fourth century A.D., down to the fall of the city of Mayapan about a century before the Spanish conquest; but after that there is a gap which is difficult to explain, just when traditions begin to throw some light on Maya history. In No. 54, R. L. Roys studies the Spanish Colonial sites, particularly the churches and convents, in this area and their relations with Maya ruins, in the light of his intimate knowledge of the country and the documentary sources. He concludes, not only that many Colonial towns and villages were on pre-Conquest sites, but also that the churches and plazas generally occupy the old ceremonial centres. This fact, and the destruction of the old buildings to provide materials for the new, are largely responsible for the gap in the archæological record, and it should now be possible to fill it by exploring suitable post-Conquest sites.

In No. 55, G. Stromsvik describes three superimposed ball-courts at the famous Classic Maya site of Copan, Honduras, together with comparable examples elsewhere. The courts are structures enclosed by lateral walls for playing a team game with a rubber ball, which in one form or another was widespread in middle America in ancient times, and which still survives on flat courts in remote parts of Mexico. It is possible that the first court at Copan, perhaps dating from the fifth century A.D., is the oldest yet discovered, and the latest may date from late in the eighth century. The latter is remarkable for the presence of three stone macaw heads tenoned into each side of the lateral structures; these may be related to the stone rings which formed a kind of goal in later courts. A feature of the report is a reconstruction drawing of the latest court and its surroundings by Miss Tatiana Proskouriakoff.

No. 56, by R. E. Smith, is a short paper describing pottery, believed to be of late Classic date, from a rubbish pit in Alta Verapaz in Guatemala. It is rather a specialized subject, and its importance lies in the fact that the archæology of Alta Verapaz is very little known.

G. H. S. BUSHNELL

EFFECT OF STREPTOMYCIN ON VARIOUS ENZYMES RESPONSIBLE FOR SYNTHESES AND DEGRADATIONS OF HIGHER SACCHARIDES

By DR. S. A. BARKER, DR. E. J. BOURNE, PROF. M. STACEY, F.R.S., and R. B. WARD
Chemistry Department, University of Birmingham

PREVIOUS workers have shown streptomycin to affect certain enzyme systems, its inhibition of the oxalacetate–pyruvate condensation[1] being particularly important. However, little has been reported of its influence on enzymes responsible for the synthesis and degradation of oligo- and polysaccharides, and this formed the subject of the investigation now described. It was considered that streptomycin might exert part of its powerful antibiotic action against mycobacteria by blocking some of the enzyme systems which build up their complex polysaccharide molecules. Such a hypothesis is particularly attractive in the case of *Mycobacterium tuberculosis*, since certain of the specific polysaccharides of this organism and the antibiotic show structural similarities, inasmuch as they are both glycosides with furanose and glucosamine components (D-arabofuranose with D-glucosamine[2] and streptofuranose with N-methyl-L-glucosamine, respectively). Furthermore, since streptomycin is mainly of a carbohydrate nature, it was felt that it might serve as either a donor or a receptor in suitable transglycosylation reactions[3] and give rise to modified streptomycins; if this happened, it could account for the relative ease with which mycobacteria can adapt themselves to streptomycin.

In order to test these theories, each enzyme solution was incubated with the appropriate substrate, in the presence and absence of streptomycin sulphate (0–15 per cent), the two digests being adjusted to the same *p*H to counteract the acidity of the antibiotic salt. At intervals, the digests were analysed for sugars by paper chromatography using (*a*) the organic phase of a butanol (40 per cent) – ethanol (10 per cent) – water (49 per cent) – ammonia (1 per cent) mixture as the solvent, with aniline hydrogen phthalate[4] and naphtharesorcinol[5] detector sprays, or (*b*) the benzylamine method[6], with ninhydrin as the detector. In addition, each sample was examined in 0·2 N acetate buffer (*p*H 5·0) on four identical ionophoretograms (600 V., 4 hr.), which were developed, severally, with aniline hydrogen phthalate[4,7], naphtharesorcinol[5], a modified Elson–Morgan reagent, and alkaline diacetyl/α-naphthol[7].

Although no evidence was obtained with the enzymes studied of a streptomycinase, or of a transglycosylation giving rise to a compound analogous to the naturally occurring mannosyl streptomycin, several interesting effects were observed, as follows.

Invertases and transfructosylases[8]. Commercial yeast 'invertase' (British Drug Houses, Ltd.), acting on sucrose, gave fructose, glucose, di- and tri-saccharides. In the presence of streptomycin sulphate (15 per cent), the reaction was retarded, particularly as regards the formation of the higher saccharides. With the 'invertase' of *Aspergillus niger* (strain 152 [9]), used as a cell-free extract from a culture grown on sucrose, the effect of streptomycin sulphate was even more apparent. Whereas the enzyme normally converts sucrose into glucose, fructose and higher saccharides, the presence of streptomycin sulphate in concentrations of 0·01 per cent and higher caused a marked inhibition of fructose formation and prolonged the life of the higher saccharides. A possible explanation of these phenomena is that invertase- and transfructosylase-activities are not always exhibited by a single enzyme, as is widely believed (cf. ref. 8), but that there may be two distinct enzymes, one of which is more sensitive to streptomycin than the other; further work to test this hypothesis is envisaged.

Nigeran synthesis. The addition of streptomycin sulphate (10 per cent) to the sucrose (10 per cent) – mineral medium used to culture *Aspergillus niger* (strain 152), and also a related strain, caused marked increases (ten- and three-fold, respectively) in the percentages of nigeran[10] in the dried mycelia. Smaller concentrations of streptomycin sulphate had correspondingly smaller effects.

Panose synthesis. A cell-free extract of *Aspergillus niger* (strain 152) produced, *inter alia*, glucose, *iso*-

maltose and panose when incubated with maltose[11]. In the presence of streptomycin sulphate, at concentrations greater than 0 1 per cent, the formation of *iso*maltose and panose was retarded

Amylomaltase. A cell-free extract of *Escherichia coli* (Monod strain) which had been cultured on maltose, when incubated with maltose, produced glucose, fructose, maltotriose, maltotetraose, etc [12]. In the presence of streptomycin sulphate (15 per cent) the formation of fructose, which arises from enzymes other than amylomaltase, was markedly reduced

Other enzyme systems Five other enzymic processes were found to be inhibited slightly by streptomycin sulphate (15 per cent), they were (*a*) dextran synthesis from sucrose by the dextransucrase of *Betacoccus arabinosaceous*, (*b*) oligosaccharide synthesis from lactose by the transgalactosylase of *Aspergillus niger* (strain 152), (*c*) oligosaccharide synthesis from cellobiose by almond emulsin[13], (*d*) the hydrolysis of amylose by salivary α-amylase, and (*e*) the hydrolysis of amylose by soya bean β-amylase[14]. There was no detectable effect of the antibiotic (15 per cent) on (*a*) the liberation of phosphate from dipotassium α-D-glucose-1 phosphate by phosphorylase, (*b*) oligosaccharide synthesis from cellobiose by *Aspergillus niger* extracts[15], or (*c*) phosphate liberation from α-glycerophosphoric acid and dipotassium α-D-glucose-1 phosphate by bovine intestinal phosphatase

Thus it will be seen that streptomycin has a modifying effect on some of the enzyme systems concerned with the synthesis of higher saccharides, and a more detailed study of these is being made

We are indebted to the Glaxo Laboratories, Ltd, for the generous provision of streptomycin sulphate and for financial assistance. [Nov. 24.

[1] Oginsky, E L, Smith, P H, and Umbreit, W W, *J Bact*, **58**, 747 (1949) Smith, P H, Oginsky, E L, and Umbreit, W W, *ibid*, 761 (1949) Umbreit W W, and Tonhazy, N E, *ibid*, 769 (1949)

[2] Haworth, W N, Kent, P W, and Stacey, M, *J Chem Soc*, 1211, 1220 (1948)

[3] Barker, S A, and Bourne, E J, *Quart Rev*, **7**, 56 (1953)

[4] Partridge, S M, *Nature*, **164**, 443 (1949)

[5] Forsyth, W G C, *Nature*, **161**, 239 (1948)

[6] Bayly, R J, and Bourne, E J, *Nature*, **171**, 385 (1953)

[7] Foster, M C, and Ashton, G C, *Nature*, **172**, 958 (1953)

[8] Bacon, J S D, *Ann Rep Chem Soc*, **50**, 281 (1953)

[9] Barker, S A, Bourne, E J, and Carrington, T R, *J Chem Soc*, 2125 (1954)

[10] Barker, S A, Bourne, E J, and Stacey, M, *J Chem Soc*, 3084 (1953)

[11] Barker, S A, and Carrington, T R, *J Chem Soc*, 3588 (1953)

[12] Doudoroff, M, Hassid, W Z, Putman, E W, Potter, A L, and Lederberg, J, *J Biol Chem*, **179**, 921 (1949) Barker, S A, and Bourne, E J, *J Chem Soc*, 209 (1952)

[13] Peat, S, Whelan, W J, and Hinson, K A, *Nature*, **170**, 1056 (1952)

[14] Donatelli, L, and Galeotti-Flori, A, *Chem Abs*, **42**, 1662 (1948)

[15] Barker, S A, Bourne, E J, and Stacey, M, *Chem and Indust*, 1287 (1953)

EXCHANGE REACTIONS IN THE ENTRY OF CATIONS INTO PLANT TISSUES

By R SCOTT RUSSELL and M J AYLAND

Department of Agriculture, University of Oxford

IT is well established that when actively metabolizing plant roots or tissue slices are transferred to solutions containing higher concentrations of ions than those to which they were previously exposed, a rapid entry of ions occurs, but within a few minutes the rate of entry decreases Conversely, when tissues are transferred to more dilute solutions an initial rapid outflow is observed[1,2]. Conflicting interpretations of this initial flux have been advanced. It has been widely held that exchange reactions or adsorption at the cell surface are the first step in ionic entry[3-6]. Evidence that the rate of absorption is not controlled by diffusion into the tissues accords with this view[7] Recently, however, Hope and Stevens[2], and following them, Butler[1], have regarded the initial flux as a diffusion process In his later work, Hope has suggested that non-diffusible anions influence the rate of absorption, but he has retained his earlier concept that ions diffuse into the "apparent free space" of tissues

The use of radioactive isotopes makes it a simple matter to study the competition of ions for entry into tissues over short intervals, and the relative importance of exchange and diffusion processes can in this way be examined If diffusion is the rate-limiting process, the entry of one cation will not be affected by the presence of another cation in low concentration However, if the presence of sites on which exchange or adsorption occurs is the controlling factor, inter-ionic competition is to be expected even in the shortest experimental periods Experiments of this type have been conducted using washed carrot disks, detached barley roots and intact barley plants In Table 1, representative results are shown for the absorption, over periods of 5–20 minutes, of labelled rubidium and cæsium in the presence and absence of other monovalent cations Even in five minutes the absorption of the labelled ion is markedly reduced by the presence of other monovalent ions The percentage reduction changes little if the experimental period is increased to twenty minutes These results are interpreted as indicating that diffusion is not a significant factor determining the rate of the initial entry of ions into the tissues studied, it is assumed that the process depends on exchange reactions at or near the cell surface. The mechanism is, however, not ‘ passive” in the sense that Broyer[3] has used that word to denote processes independent of metabolism. It has been found that the initial inward flux can be reduced by 2 4-dinitrophenol and by sodium azide at 25° C (Table 2) In work with the latter substance it has been demonstrated that the observed effect was not due to the sodium ions in

Table 1 INTERACTION OF CATIONS IN THE INITIAL FLUX OF ABSORPTION (TEMPERATURE 25° C)

Tissue	Labelled ion $M \times 10^{-3}$	Interfering ion $M \times 10^{-3}$	% reduction of absorption of labelled ion induced by interfering ion after			Statistical significance (P)
			5 min	10 min	20 min	
Carrot disks	Rb 0 2	K 12 8	72 5	81 3	82 5	(Unreplicated)
,,	Cs 0 2	K 12 8	65 6	74 1	74 0	0 001
,,	Cs 1 6	K 12 8	57 9	57 1	55 7	0 02
,,	Cs 0 2	Rb 0 2	48 2	—	—	0 001
,,	Cs 0 2	Rb 0 2	25 7	—	—	0 001
Barley roots	Cs 0 2	Rb 12 8	64 1	72 4	84 6	0 01
Intact barley	Cs 0 2	Rb 0 2	30 4	—	—	0 001

Table 2 EFFECT OF 2 4 DINITROPHENOL AND SODIUM AZIDE ON THE ABSORPTION OF CÆSIUM BY PLANT TISSUES IN A FIVE-MINUTE PERIOD AT 25° C

Tissue	Cæsium $M \times 10^{-3}$	Azide or DNP $M \times 10^{-3}$	Absorption μgm / c c tissue	% reduction by DNP or azide	Statistical significance (P)
Carrot disks	0 2	DNP 0 1	61 56	41 0	0 001
,,	1 6	DNP 0 1*	526 11	25 3	0 01
Barley roots	1 6	Azide 0 2	29 16	14 0	0 01

* Administered for 30 minutes immediately before absorption period

sodium azide Other aspects of these studies will be discussed elsewhere

In experiments with intact plants it has been possible to demonstrate ionic interactions in other phases of the absorption process[9] In experimental periods of four hours it has been found that the interaction of potassium with rubidium is different with respect to (*a*) the absorption of rubidium, and (*b*) its transference to the shoots. Moreover, the nature of these interactions is dependent on the initial nutrient status of the plants (Table 3) These results indicate that the two ions must interact in at least two distinct phases of the absorption process, namely, the initial entry into the roots and in the mechanism whereby ions are transferred across the symplast to the stele The complexity of the processes in which ions compete is further indicated by a number of other results which will be discussed more fully elsewhere (*a*) Competition affects not only the initial inward movement of ions (cf Table 1) but also their rate of exchange when the tissues are transferred to unlabelled solutions. (*b*) When equivalent concentrations of rubidium and cæsium are administered for five minutes it is found that rubidium is more effective than cæsium in inhibiting the entry of the other ion—a result contrary to that obtained with inert exchange systems

It is concluded, therefore, that the process of ionic accumulation is considerably more complex than that envisaged by Jacobsen and Overstreet[5], who postulated a single exchange step for ions of either sign whereby they are bound to carrier molecules which transfer them across the cytoplasm No evidence as yet available, however, appears to conflict with the view that reactions of the type they envisage may occur after the initial entry of ions by exchange into the tissues For reasons discussed elsewhere[9], this hypothesis is attractive, but it is, as yet, unsupported either by the identification of the carrier or by evidence as to the manner whereby ions are bound on the carrier Epstein[4] has endeavoured to examine the latter question by a kinetic study of the interaction of ions for entry into tissues If the conclusions here presented are correct, his interpretation is unwarranted since ions interact for sites unconnected with the mechanism which is responsible for their transference across the cytoplasm Moreover, the manner in which he analysed his results appears open to question He employed the procedure developed by Lineweaver and Burk[8] for enzymatic studies For this procedure to be applicable to salt uptake, a linear relationship must exist between the reciprocal of the rate of absorption and the reciprocal of the external concentration Epstein demonstrated the linearity of this relationship for the absorption of rubidium from solutions of concentrations 2–50 milli-equivalents per litre In the present work, however, a concentration-range extending down to 0 1 milli-equivalents per litre was used with carrot disks under similar conditions and it was found that the relationship was not linear over this wider concentration range The results of an experiment using cæsium at concentrations 0 1–12 8 milli-equivalents per litre are shown in Fig 1 Similar results were obtained with rubidium It is apparent from Fig 1 that a linear relationship might have been inferred from the results which lie within the range employed by Epstein Thus it must be concluded that theoretical interpretations based on such data are likely to be misleading until the steps in the overall process of ionic absorption are more fully elucidated

Table 3 THE ABSORPTION AND DISTRIBUTION OF RUBIDIUM IN YOUNG BARLEY PLANTS PROVIDED WITH POTASSIUM PRIOR TO, OR SIMULTANEOUSLY WITH, RUBIDIUM DURATION OF EXPERIMENT, 24 HOURS

	Pretreated for 48 hr with 0 5×10⁻³ M potassium		Not pretreated with potassium		S D (P=0 05)
	Concentration of rubidium $M \times 10^{-3}$				
	1	10	1	10	
Rubidium absorbed mgm /plant					
K absent from external solution	1 33 *1 122*	2 33 *1 366*	5 20 *1 714*	7 29 *1 866*	*0 086*
2×10^{-2} M K present in external solution	0 324 *0 510*	2 35 *1 370*	1 20 *1 067*	6 15 *1 788*	
% absorbed rubidium in shoots					
K absent from external solution	43 87	44 04	55 69	63 66	4 63
2×10^{-2} M K present in external solution	36 90	40 79	52 33	66 82	

When a logarithmic transformation was necessary for statistical analysis the transformed values are shown in italics

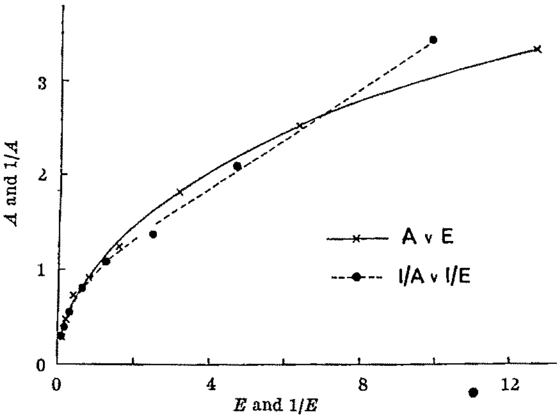


Fig 1 Relationship between external concentration and absorption of cæsium by carrot disks in 4 hr at 25° C *A*, Cæsium absorbed in milligrams/20 disks, *E*, external concentration of cæsium in milli-equivalents/litre The relationships between these quantities and between their reciprocals are shown

We wish to acknowledge our indebtedness to the Agricultural Research Council and to the Ministry of Supply for support at different stages of this work

[Nov 29

---

[1] Butler, G W, *Physiol Plant*, **6**, 617 (1953)
[2] Hope A B, *Aust J Biol Sci*, **6**, 396 (1953) Hope, A B, and Stevens, P G, *Aust J Sci Res*, B, **5**, 335 (1952)
[3] Broyer, T C, "Mineral Nutrition of Plants", 87 (Wisconsin, 1951)
[4] Epstein, E, Proc Oak Ridge Summer Symposium, **4** (1952), *Nature*, **171**, 83 (1953) Epstein, E, and Hagen, C E, *Plant Physiol*, **27**, 467 (1952)
[5] Jacobsen, L, and Overstreet, R, *Amer J Bot*, **34**, 415 (1947)
[6] Lundegårdh, H, *Physiol Plant*, **3**, 103 (1950)
[7] van der Honert, T H, *Versl Vergaal Vereen Profsta Parsoneel*, **16**, 86 (1936)
[8] Lineweaver, H, and Burk, D, *J Amer Chem Soc*, **56**, 658 (1934)
[9] Russell, R Scott, Soc Exp Biol, Symposium, **8**, 343 (1954)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Analgesic and Antipyretic Activities of 4-Hydroxy*iso*phthalic Acid

4-HYDROXY*iso*PHTHALIC acid is a by-product of the manufacture of salicylic acid by the Kolbe–Schmitt reaction and has been found to be a major constituent of the 'brown dust' residues from the sublimation process for the purification of salicylic acid[1] Analysis of a typical sample of 'brown dust' showed it to contain 10 per cent of salicylic, 82 per cent of 4-hydroxy*iso*phthalic and 3 per cent of 2-hydroxy*iso*phthalic acids, together with some inorganic material From this source there is thus potentially available a considerable quantity of 4-hydroxy*iso*phthalic acid, the chemistry of which is being investigated as part of a research programme on the Kolbe–Schmitt reaction at the Chemical Research Laboratory[2] From a consideration of its structural similarity to salicylic acid, it was suggested at the Chemical Research Laboratory that 4-hydroxy*iso*phthalic acid might also possess similar pharmacological properties Accordingly, in February 1954, a pharmacological investigation was initiated at Ware and, since the findings were favourable, biochemical studies were also undertaken

In the initial experiments, drugs were administered by the intraperitoneal route, aspirin and phthalic acid derivatives being suspended in 5 per cent gum acacia In analgesic tests, a simplified form of the analgesiometer of Green, Young and Godfrey[3] was used, which measures responses in terms of the pressure, applied to the tip of the tail, required to elicit a squeak from a young rat This method showed that 4-hydroxy*iso*phthalic acid undoubtedly possesses analgesic properties, its median effective dose being 303 (limits 261–353) mgm per kgm In comparative tests it exhibited 4 1 (limits 3 2–5 5) per cent of the activity of codeine The median lethal dose (*LD*50) for young rats was 1,071 (limits 968–1,185) mgm per kgm, and a dose of 600 mgm per kgm. was tolerated by all eighty-seven rats which received it Comparison of the *LD*50 of 4-hydroxy*iso*phthalic acid with the corresponding published figures for codeine[4] indicates that it possesses about 10 per cent of the toxicity of codeine Compared with 4-hydroxy*iso*phthalic acid aspirin was both more toxic and less effective The *LD*50 was 541 (limits 485–603) mgm per kgm, and a dose of 300 mgm per kgm, which was tolerated by all rats, failed to show any analgesic effect, although higher doses appeared to do so

In comparative tests of antipyretic activity in rabbits, it was found that 4-hydroxy*iso*phthalic acid was about as effective as aspirin in counteracting fevers caused by a preparation of pyrogen from *Proteus vulgaris*

Since 4-hydroxy*iso*phthalic acid promised to have clinical value of a type similar to, but greater than, aspirin, a chronic toxicity test was carried out by administering the drug at 0 5 and 1 0 per cent in the diet to mice for a period of fourteen weeks In this experiment, it exhibited very low toxicity, of the same order as that of aspirin, which was used for reference

Analgesic tests were also performed with 2-hydroxy*iso*phthalic, phthalic, *ter*ephthalic and *iso*phthalic acids The 2-hydroxy acid was about equipotent to the 4-hydroxy, while the unsubstituted acids showed slight activity

Preliminary investigations on the excretion of 4-hydroxy*iso*phthalic acid by rats showed that within 24 hr about 40 per cent of a 10-mgm dose given by stomach tube was excreted unchanged in the urine and about 25 per cent in the fæces The method of estimation was based on the reddish-purple colour formed when the acid is allowed to react with ferric nitrate Acid hydrolysis failed to increase the amount of free 4-hydroxy*iso*phthalic acid, suggesting the absence of certain conjugated forms from the urine, while the absence of other possible metabolites, such as salicylic, *p*-hydroxybenzoic and gentisic acids, was demonstrated by means of paper electrophoresis

Clinical trials to investigate the possible therapeutic applications of these findings are in progress

The 'brown dust' was kindly supplied by Monsanto Chemicals, Ltd We wish to thank the directors of Allen and Hanburys, Ltd, and the director of the Chemical Research Laboratory, Teddington, for permission to publish this work.

G B CHESHER
H. O J. COLLIER
F A. ROBINSON
E P. TAYLOR
Research Division,
Allen and Hanburys,
Ltd,
Ware, Herts

S E HUNT
J. IDRIS JONES
A S LINDSEY
Chemical Research Laboratory
(Department of Scientific
and Industrial Research),
Teddington, Middlesex

Nov. 15.

[1] Report of Chemistry Research Board, 66–67 (1952), 36 (1953) (London H M S O)

[2] Hales, J L, Jones, J Idris, and Lindsey, A S, *J Chem Soc*, 3145 (1954)

[3] Green, A F, Young, P A, and Godfrey, E I, *Brit J Pharmacol*, 6, 572 (1951)

[4] Poe, C F, Strong, J G, and Witt, N F, *J Pharmacol*, 61, 62 (1937)

Imidazole Complexes of Myoglobin and the Position of the Hæm Group

WE have prepared complexes of imidazole, 1-methyl imidazole and 4-methyl imidazole with various species of myoglobin, and crystallized them in forms previously described[1], the X-ray diffraction patterns of the crystals were then compared with those obtained from corresponding forms of met-myoglobin crystals The results, which were similar for all three imidazoles, are summarized in Table 1 (In each case a large excess of imidazole was used without this precaution combination is always incomplete)

Table 1

Species	Form		*a*	*b*	*c*	*β*	Intensities
Sperm-whale (ammon sulphate)	Met- Imid-	*A* *A*	64 6 A 64 4	31 1 A 30 7	34 8 A 34 7	105 5° 105 5°	Scarcely changed
Sperm-whale (phosphate)	Met- Imid-	*B* *B*	48 9 48 8	40 2 40 3	79 3 78 5		Considerable changes
Gentoo penguin (ammon sulphate)	Met- Imid-	 *I*	(no crystals formed) 94 5	 38 3	 43 5		
Gentoo penguin (phosphate)	Met- Imid-	*G* *H*	48 3 106 4	80 2 39 1	78 5 45 3		

Three types of behaviour have been observed. (a) In sperm-whale monoclinic crystals (type *A*), the imidazole derivative is nearly isomorphous with the metmyoglobin. The cell dimensions are virtually unaltered, if anything slightly decreased; the intensities are scarcely changed, the differences being of the same order of magnitude as those between carbonmonoxy- and met-myoglobin crystals. (b) In sperm-whale orthorhombic crystals (type *B*), the imidazole derivative has again nearly the same cell dimensions as the metmyoglobin, but the intensities are very substantially changed, and are appreciably different in the different imidazole derivatives. (c) In gentoo penguin myoglobin, either grown in ammonium sulphate or in phosphate, the addition of an imidazole group produces a radical change in crystal packing. In ammonium sulphate the metmyoglobin will not crystallize at all, whereas the imidazole derivative gives orthorhombic crystals of type I ($P2_12_12_1$, 4 mol./cell); in phosphate the metmyoglobin gives the face-centred type *G* ($C222_1$, 8 mol./cell), while the imidazole derivative gives the orthorhombic type *H* ($P2_12_12_1$, 4 mol./cell).

These results give some indications about the location of the hæm group in myoglobin. Broadly, we can imagine three main types of site for the group: (i) embedded deeply inside the molecule; (ii) on the side of a wide cleft or groove; and (iii) on the surface. In case (i) the attachment of a substantial group such as methyl-imidazole (which is a roughly circular disk of dimensions about 7 A. × 3.7 A., by no means negligible in comparison with the molecule of myoglobin itself which, if spherical, would have a diameter of about 32 A.) should change the dimensions of the molecule and appreciably increase at least some of the cell dimensions in all the crystal forms; in case (ii) a group attached to the hæm would exert no steric effects at all and imidazole crystals would be isomorphous with metmyoglobin crystals in all forms. On the other hand, in case (iii) one would anticipate that in some forms of crystal the hæm group would be distant from points of contact between molecules, and no changes in structure would be produced by attachment of imidazole to it (as observed in sperm-whale monoclinic crystals); whereas in others the imidazole group attached to hæm would be near a point of contact and would cause appreciable distortions in packing (as in sperm-whale orthorhombic crystals) or would even impose a completely new type of packing (as in penguin crystals).

Hence it appears to us very probable that the hæm group is located on the surface of the myoglobin, though it must be realized that any conclusion is bound to be tentative, partly because it is easy to imagine various configurations of the molecule intermediate between the three extremes defined above, partly because it is not certain (though it is very likely) that the molecule of penguin myoglobin has a structure similar to that of sperm-whale myoglobin. Finally, it may be noted that these surmises are not directly applicable to hæmoglobin, about the hæm positions in which differing conclusions have been drawn by different workers (see, for example, St. George and Pauling[2] and Keilin[3]); but they would be relevant if, as has more than once been suggested, the hæmoglobin molecule is made up of four sub-units each resembling that of myoglobin (in architecture, not amino-acid composition). In that case, there would be no necessary inconsistency even if the hæm groups of hæmoglobin were proved to be 'inside', since the arrangement of the sub-units (each having its hæm 'outside') might easily lead to such a configuration; equally, no difficulty would arise if the hæm groups of hæmoglobin were shown to be 'outside'.

J. C. KENDREW
R. G. PARRISH*

Medical Research Council
Unit for the Study of the Molecular Structure
of Biological Systems,
Cavendish Laboratory,
Cambridge.
Nov. 29.

---

* Merck Post-Doctoral Fellow of the U.S. National Research Council at the Cavendish Laboratory, Cambridge, 1952–54. Present address: Department of Physics, University of Michigan, Ann Arbor, Michigan.

[1] Kendrew, J. C., Parrish, R. G., Marrack, J. R., and Orlans, E. S., *Nature*, **174**, 946 (1954).

[2] St. George, R. C. C., and Pauling, L., *Science*, **114**, 629 (1951).

[3] Keilin, D., *Nature*, **171**, 922 (1953).

Acetylation of Sulphanilamide in Plants

IN animals, sulphonamides are detoxified most commonly by acetylation of the free amino-group, a process usually localized in the liver[1]. In the course of a study of the movement of sulphanilamide in plants[2], it was found that part of the free drug became bound within the plant and that the change could be reversed by acid hydrolysis. The possibility that this change in the drug was due to acetylation has been investigated.

Broad bean plants (*Vicia faba* L.) were grown for thirty-three days with their roots immersed in an aqueous solution of sulphanilamide (100 μgm./ml.). The roots, stems and leaves of treated plants were sampled separately, killed in ether and the sap expressed[3]. 0.2-ml. aliquots of sap from treated plants were run on paper chromatograms (Whatman No. 1) in an *n*-butanol – acetic acid – water solvent system[4] (50–15–35 or 40–10–50) or an *n*-butanol – ammonia – water system[5] (40–10–50). In addition, sulphanilamide and acetyl sulphanilamide were added to the sap of untreated plants to give a final concentration of 50 μgm./ml. of the drug, and 0.2-ml. aliquots of these control solutions were run as markers. Chromatograms were run for 16 hr. at 25° C. and sulphanilamide spots were located by diazotization with a spray of 0.1 per cent sodium nitrite in glacial acetic acid and the addition of a coupling component, N-β-sulphatoethyl-*m*-toluidine[6] in 95 per cent butanol. The chromatograms showed the presence of sulphanilamide in the leaves of treated plants; but there was little free drug in the roots although bound drug could be revealed by hydrolysis. After the first diazotization and coupling, the papers were cut into sections 1 cm. × 2 cm. from the sulphanilamide spots to the solvent front, and each section was hydrolysed by boiling for 15 min. in 2 ml. *N* hydrochloric acid, the acid neutralized and the diazo colour produced. By measuring the optical density of the colour of these solutions in a spectrophotometer at 510 mμ, the position of acetyl sulphanilamide on the paper could be determined. Chromatograms of sap from treated plants showed spots with the same R_F value as acetyl sulphanilamide, indicating that acetylation of sulphanilamide occurs in plant tissue as in animal. There were greater concentrations of the acetyl compound in roots than in stems or leaves.

R_F values of sulphanilamide and acetyl sulphanilamide dissolved in various media were compared

Table 1 Comparison of R_F Values of Sulphanilamide and Acetyl Sulphanilamide in Various Media

Medium	Solvent system			
	Butanol – acetic acid – water		Butanol – ammonia – water	
	Sulphanil-amide	Acetyl sulph	Sulphanil-amide	Acetyl sulph
Water	0 64	0 80	0 59	0 79
Sap from treated plants	0 47	0 71	0 54	0 73
Sap from untreated plants with drug added	0 57	0 77	0 57	0 77

Differences of *p*H over the range 4 5–13 0 produced a change of only 0 01 in the R_F value , but the drugs in plant sap had lower R_F values than in water. This effect became more pronounced with longer exposure in plant sap, particularly with sap from treated plants (Table 1) The R_F value of sulphanilamide or acetyl sulphanilamide added to plant sap could be lowered to the same extent as that for the drug in sap from treated plants if an interval of 24 hr was allowed between adding the drug and running the chromatogram The butanol – ammonia – water system gave better separation and less tailing with the drugs in expressed sap than the butanol – acetic acid – water system

Acetylation in plants is being studied in further detail, but this preliminary note is published to direct attention to a process which may be a common phenomenon in plant tissues

D Rudd Jones
Jenifer Wignall

Butterwick Research Laboratories,
Imperial Chemical Industries, Ltd ,
Welwyn, Herts
Oct 12

[1] Harris, J S, and Klein, J R, *Proc Soc Exp Biol N Y*, 38, 78 (1938)
[2] Crowdy, S H, and Jones, D Rudd (unpublished work)
[3] Crowdy, S H, and Pramer, D, *Ann Bot N S* (in the press)
[4] Steel, A E, *Nature*, 168, 877 (1951)
[5] Longenecker, W H, *Anal Chem*, 21, 1402 (1949)
[6] Rose, F L, and Bevan, H G L, *Biochem J*, 38, 116 (1944)

Rat Liver Xanthine Oxidase in Carbon Tetrachloride Poisoning

During the course of experiments dealing with the effect of some hepatotoxic drugs on rat liver xanthine oxidase, it was found that this enzyme is activated when carbon tetrachloride is administered in a single necrogenic dosage The present communication presents results obtained in normal young rats injected subcutaneously with 0 1 ml /100 gm body-weight

Male Wistar white rats weighing 90–195 gm on a well-balanced diet were used throughout this study The animals were killed by decapitation 3–48 hr after the administration of the drug and food was withdrawn during the experimental period Normal controls showed that the injection of 0 1 ml /100 gm body-weight caused an acute congestion of the liver with a microscopic picture of focal necrosis characteristic of carbon tetrachloride injury, but no death occurred

Liver xanthine oxidase was determined by the method of Axelrod and Elvehjem from the oxygen uptake in a conventional Warburg manometer apparatus at 37° C , using xanthine as a substrate and air as the gas phase[1] The high endogenous respiration of liver homogenates does not permit the accurate assay of xanthine oxidase, particularly in cases where the activity of this enzyme is low The incubation of the homogenate at 37° C for 40 min before tipping the substrate partly suppressed the endogenous respiration. Recently, Dhungat and Sreenivasan[2] substituted a phosphate buffer of *p*H 7 4 for a pyrophosphate buffer of *p*H 8 6 in the determination of xanthine oxidase, based on the observation of Dixon and Elliott[3] that pyrophosphate inhibits endogenous respiration Therefore, this important improvement of the original method of Axelrod and Elvehjem was used in our experiments.

Table 1 Liver Xanthine Oxidase and Xanthine Dehydrogenase of Rats intoxicated with Carbon Tetrachloride and previously treated with Sodium Xanthine and Vitamin B_{12}

Conditions	Xanthine oxidase (c mm oxygen/gm dry-weight in 60 min) Average values	Xanthine dehydrogenase (μgm formazan/mgm dry-weight) Average values
Normal, starved 24 hr	1,223	1 6
Normal, starved 48 hr	921	1 4
CCl_4 24 hr *	1,483	1 6
CCl_4 24 hr †	1,771	0 9
CCl_4 48 hr †	1,325	1 0
Sodium xanthine starved 24 hr	1,295	0 7
Sodium xanthine + carbon tetrachloride 24 hr †	883	0 5
Vitamin B_{12} normal diet	1,786	1 6
Vitamin B_{12} + carbon tetrachloride 24 hr †	2,460	1 9
Vitamin B_{12} + carbon tetrachloride 48 hr †	1,457	2 0

* Rats starved 24 hr , injected with carbon tetrachloride and killed 3 hr later

† Time of starvation after the administration of carbon tetrachloride

The xanthine dehydrogenase activity in rat liver was also measured using the anaerobic reduction of the colourless dye triphenyltetrazolium chloride in a Thunberg vacuum tube, and the red formazan extracted with toluol or with petroleum ether (ligroin) when the livers were rich in lipids[4]. The results for xanthine oxidase activity were expressed in c mm. of oxygen consumed in 60 min per gm dry-weight and for xanthine dehydrogenase activity in μgm. formazan per mgm dry weight.

Normal well-fed rats gave values for xanthine oxidase of 1,638 ± 168 c mm oxygen and rats starved for 24 hr and 48 hr values of 1,223 ± 32 c mm and 921 ± 177 c mm respectively Starved rats injected with carbon tetrachloride showed increased values which were statistically significant. When

Table 2 Oxidation of Xanthine by Liver Homogenates in Normal Rats and Rats treated with Carbon Tetrachloride, measured colorimetrically

Conditions	No of rats	Average weight (gm)	μgm xanthine/gm liver		
			Incubation time (min)		
			0	120	180
Normal	7	67	580	436	150
Carbon tetrachloride 24 hr *	7	72	314	8	0
,, ,, 24 hr *	7	134	455	22	0
,, ,, 48 hr *	3	195	476	73	72
,, ,, + vitamin B_{12} 24 hr †	3	220	576	0	0
Carbon tetrachloride + vitamin B_{12} 24 hr †	2	67	700	0	0
Carbon tetrachloride + vitamin B_{12} 48 hr †	2	60	810	0	0

* Time of starvation after the injection of carbon tetrachloride (0 1 ml /100 gm body-weight)

† Vitamin B_{12} (15 μgm 24 hr before the administration of carbon tetrachloride)

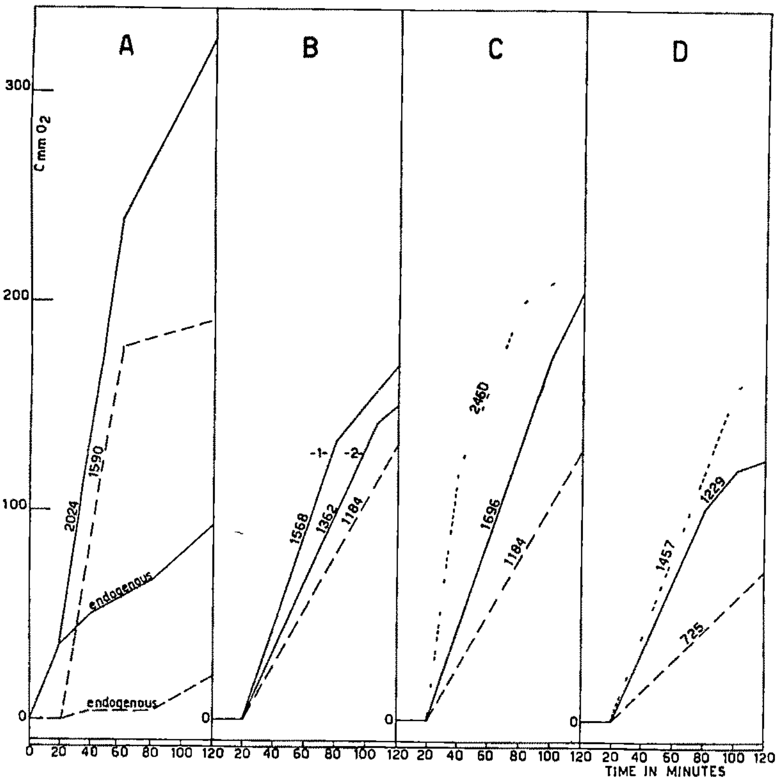


Fig 1 Activation of rat liver xanthine oxidase

(*A*) *in vitro* activation — — — —, normal , ————, same homogenate added with carbon tetrachloride (0 1 ml /10 ml)
(*B*) *in vitro* and *in vivo* activation — — — —, liver of normal rat starved for 24 hr , ——-1-——, *in vitro* addition of carbon tetrachloride , ——-2-——, xanthine oxidase rat starved 24 hr , injected with carbon tetrachloride and killed 3 hr later
(*C*) *in vivo* activation — — — —, normal rat starved 24 hr , ————, rat starved 24 hr and injected with carbon tetrachloride , , rat injected with vitamin B_{12}, and after 24 hr receiving carbon tetrachloride and then starved for 24 hr
(*D*) *in vivo* activation — — — —, normal rat starved 48 hr , ————, rat starved 48 hr and injected with carbon tetrachloride , , the same as in (*C*) but starved 48 hr

(Numbers on graph represent values of xanthine oxidase in c mm oxygen/gm dry-weight/60 min)

starved for 24 hr. and killed 3 hr after administration of carbon tetrachloride, increased values of xanthine oxidase were obtained ($t = 3\ 17$, $P < 2$ per cent), and for those killed after 24 hr and 48 hr. the values had still greater significance ($t = 5\ 9$, $P < 1$ per cent, and $t = 3\ 51$, $P < 1$ per cent)

Some typical results are shown in Fig 1 and Table 1 The *in vitro* addition of carbon tetrachloride (0 1 ml to 10 ml of the liver homogenate) activated the xanthine oxidase as shown in Fig 1, *A* and *B* It is interesting to note that the xanthine dehydrogenase activity decreased in the liver of the intoxicated rats (Table 1)

The activation of xanthine oxidase in rats treated with carbon tetrachloride was shown to be due to the oxidation of the substrate, as confirmed by simultaneous experiments in which the xanthine was measured colorimetrically after 120–180 min of the incubation of the whole system according to the method of Litwak *et al* [5]. These results are summarized in Table 2. The livers of the rats injected with carbon tetrachloride and killed after 48 hr. showed a smaller increase of activity than those killed after 24 hr , a fact possibly related to the regeneration of the liver during this time

It is known that sodium xanthine and liver extracts containing xanthine are able to protect the rat liver against the necrosis occurring in carbon tetrachloride poisoning[6] Experiments were carried out to find the effect of sodium xanthine in normal rats and rats treated with carbon tetrachloride as well as of vitamin B_{12} (cobalamin), which was claimed by Popper *et al* [7] to prevent liver necrosis Sodium xanthine (100 mgm /100 gm body-weight) had no effect on liver xanthine oxidase in normal rats, but inhibited its enzyme activity of about 50 per cent in rats injected with carbon tetrachloride However, xanthine dehydrogenase decreased in normal as in poisoned rats (Table 1) Vitamin B_{12}, kindly supplied by Merck and Co , Rahway, N J , injected at 15 μgm /100 gm. body-weight, was without effect on the xanthine oxidase and dehydrogenase activities of normal rats , but both these activities were much increased in rats treated with carbon tetrachloride (Table 1 and Fig 1, *C* and *D*)

The results reported here indicate that liver xanthine oxidase is activated and xanthine dehydrogenase partly inhibited by carbon tetrachloride when injected in a single dose Sodium xanthine, which protects the rat against liver injury in carbon tetrachloride poisoning, inhibits the oxidase and dehydrogenase activities of this enzyme in intoxicated animals However, vitamin B_{12} increases these activities notwithstanding its protective effect in this experimental intoxication.

Gilberto G Villela
Emilio Mitidieri

Division of Biochemistry,
Oswaldo Cruz Institute,
Rio de Janeiro. Sept. 24.

[1] Axelrod, A E , and Elvehjem, C A , *J Biol Chem* , **140**, 725 (1941)
[2] Dhungat, S B , and Sreenivasan, A , *J Biol Chem* , **208**, 845 (1954)
[3] Dixon, M , and Elliott, K A C *Biochem J* , **23**, 812 (1929)
[4] Villela, G G , *Rev Bras Biol* , [**14**, 455 (1954)]
[5] Litwak, J W , Bothwell, J W , Williams, jun , J N and Elvehjem, C A , *J Biol Chem* , **200**, 303 (1953)
[6] Forbes, J C , and Neale, R C , *Proc Soc Exp Biol Med* , **34**, 319 (1936)
[7] Popper, H , Koch-Weser, D , and Szanto, P B , *Proc Soc Exp Biol Med* , **71**, 688 (1949)

Infectivity and Nucleic Acid Content of Influenza Virus

Much of the present belief that the genetic properties of viruses are carried by their nucleic acid moieties arises from recent work with plant and bacterial viruses Infection of the host cell has been shown to result in the formation of particles which, though closely related to the accompanying virus components, are non-infectious Analyses indicate that the non-infectious material contains little or none of the nucleic acid present in the infectious particle[1]

Methods have been described for producing influenza virus preparations which differ from 'standard' virus in possessing high hæmagglutinating activity but low infectivity[2] Such preparations have been termed 'incomplete', the degree of incompleteness being indicated by the ratio of infectivity to hæmagglutinin, *I*/*A* It seemed worth while to see if any correlation existed between the degree of incompleteness and the nucleic acid content of the virus particle The preliminary results of such an investigation are reported here.

All experiments were carried out with the *PR*8 strains of influenza virus Infected allantoic fluids, harvested 30–42 hr after inoculation with virus diluted to $ID_{50} = 10^{-4}$, served as a source of standard virus, whereas incomplete virus was prepared from infected allantoic fluid harvested after two or three serial passages (each 12–16 hr) of undiluted (initially $ID_{50} = 10^{-9}$) inoculum[2,3] Hæmagglutinin and infectivity titres[4] were determined on the freshly harvested fluids. The virus was purified by adsorption on to, and elution from, human red cells followed by two cycles of differential centrifugation (45,000 *g*, 30 min , 6,000 *g*, 10 min) Yields of purified virus varied from 20 to 60 per cent The virus was precipitated with trichloracetic acid, dialysed against distilled water and dried from the frozen state *in vacuo* The degree of purity was estimated by comparing the ratio hæmagglutinin units/mgm. dry-weight Values given by standard and incomplete virus preparations fell within the same range, 6–12 × 10^4

It has recently been found that influenza virus contains only ribonucleic acid in significant amounts, no appreciable amount of deoxyribonucleic acid being present The ribonucleic acid content could be conveniently estimated by measuring the ultra-violet absorption at 260 mμ of a hot 10 per cent sodium chloride extract of defatted virus. Values of approximately 0 8 per cent for standard virus preparations were obtained[4].

In Fig 1 are plotted nucleic acid values of purified virus prepared from infected allantoic fluids the *I*/*A* ratios of which varied from $10^{6\ 5}$ to $10^{3\cdot 2}$ There is a considerable spread in these ratios for the different experimental groups, due largely to seasonal variations in the eggs. Also, virus preparations having similar *I*/*A* values show an appreciable range of ribonucleic acid values, and this appears to be partly due to varying lipid content. Despite these variations, it is clear that reduction in the *I*/*A* ratio is accompanied by a progressive decrease in the nucleic acid content, the latter being expressed as the percentage per mgm. dry-weight of virus As originally reported[2], however, incomplete virus has a lower sedimentation constant than standard virus, and recent work[5] indicates that this may be due to the high lipid content (and hence lower density) of the former Thus, expressing the above values on a weight of ribonucleic acid per virus particle basis would increase the difference between the ribonucleic acid content of standard and incomplete virus. The magnitude of the change must await the results of virus particle counts

It was thought possible that some indication of the specificity of the missing components in incomplete virus could be obtained by comparing the gross proportion of bases in preparations of different *I*/*A* ratios. When analysed by chromatography following hydrolysis with *N* hydrochloric acid[6], the nucleic acid isolated from the sodium chloride extract gave spots coinciding in R_F values with adenine, guanine, cytidylic acid and uridylic acid obtained from yeast nucleic acid Six preparations with *I*/*A* values ranging from $10^{6\cdot 5}$ to $10^{4\ 3}$ gave identical proportions of base

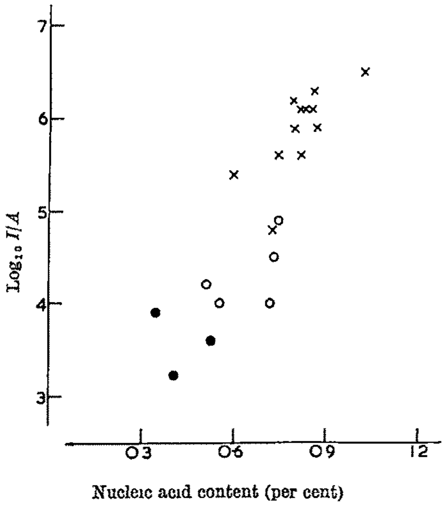


Fig 1 Relationship between the infectivity/hæmagglutinin ratio and the nucleic acid content of influenza virus ×, Single passage (0 05 ml , $ID_{50} = 10^{-4}$) , ○, double passage (each 1 0 ml undiluted fluid) , ●, triple passage (each 1 0 ml undiluted fluid)

It seems not unreasonable to postulate that loss of infectivity is caused by the lack of a small proportion only of genetic units corresponding to the observed decrease in nucleic acid content Sufficient nucleic acid is present in particles which are 99 per cent incomplete to suggest that they still contain genetic material which could contribute to the 'genetic pool' in recombination experiments, and such has been found to be the case[7] However, the present limited evidence does not indicate whether the decrease in infectivity is due to a random or orderly loss of genetic units

G L. Ada
Beverley T. Perry
Walter and Eliza Hall Institute of Medical Research,
Melbourne

Sept 9

---

[1] Markham, R , Farad Soc Discuss , No 11, 221 (1951) Commoner, B , Yamada, M , Rodenberg, S G , Wang, T -Y , and Basler, E , *Science*, 118, 529 (1953) See review, "The Properties of Bacteriophages", by Epstein, H T , in "Advances in Virus Research", p 1 (Academic Press, Inc , N Y , 1953)

[2] von Magnus, P , *Arkiv Kemi* , *Swed Acad Sci* , 24 B, No 7 (1946)

[3] Fazekas de St Groth, S , and Graham, D M , *Brit J Exp Path* , 35, 60 (1954)

[4] Ada, G L , and Perry, B T , *Aust J Exp Biol* , [32, 453 (1954)]

[5] Uhler, M , and Gard, Sven, *Nature*, 173, 1041 (1954)

[6] Smith, J D , and Markham, R , *Biochem J* , 46, 509 (1950)

[7] Burnet, F M , and Lind, P E , *Aust J Exp Biol* (in the press)

Total Sugar and Nitrogen Contents of Jute Plants, with Special Reference to the Flowering Stage

The relative increase of carbohydrate over nitrogen has been regarded as a sign of a shift from the vegetative to the reproductive state in plants The ratio of soluble sugar and nitrogen in normal and in photoperiodically induced plants was determined in jute, which has been found to be a short-day plant[1] Total sugar and total nitrogen calculated as percent-

Table 1 *Corchorus capsularis* AND *C olitorius* SOWN ON APRIL 20, 1954

C capsularis					*C olitorius*				
Treatment	Sampling date in days after sowing	% Sugar (*A*)	% Nitrogen (*B*)	*A*/*B*	Treatment	Sampling date in days after sowing	% Sugar (*A*)	% Nitrogen (*B*)	*A*/*B*
10 hr (in flower)	29	0 879	1 939	0 04533	10 hr (in flower)	21	0 4155	2 215	0 1875
Control (vegetative)	29	0 0245	5 0225	0 004877	Control (vegetative)	21	0 2205	2 044	0 1079
					,, (in flower)	117	0 391	2 044	0 1914

age of dry-weight of the whole plant are given in the tables as a mean of four plants

The sugar–nitrogen ratio is comparatively higher in the plants which are induced to flower early The work of Parker and Borthwick[2] and Murneek[3] on soybeans gives similar results

The sugar and nitrogen contents of plants before, at, and after flowering were determined at intervals of five days in *C olitorius* sown on March 15 It is known[4] that this species when sown in March flowers very early under natural conditions The results are given in Table 2

Table 2 *C olitorius* SOWN ON MARCH 15, 1954

Date of sampling	% Sugar	% Nitrogen	Sugar/nitrogen
26 3 54	11 046	3 65	3 026
31 3 54	2 5	4 2203	0 5978
5 4 54 (Flowering)	0 2763	0 7781	0 355
10 4 54	4 6135	6 244	0 7393
15 4 54	1 614	1 203	1 342

Both the sugar and nitrogen contents are found to fall considerably at the flowering stage, but rise again after the date of first initiation of flowers

Analyses of plants sown in the normal season and induced photoperiodically to flower early, at regular intervals before and after flowering, will be of interest For a more complete knowledge of the relationship, determinations of total carbohydrates including starch will be necessary.

SUMITRA TALUKDAR

Botanical Laboratory,
Presidency College,
Calcutta.
Sept. 20

---

[1] Sen Gupta, J C, and Sen, N K, *J Ind Agric Sci*, 14, 196 (1944)

[2] Parker, M W, and Borthwick, H A, *Bot Gaz*, 100, 651 (1939)

[3] Murneek, A E, "Nutrition and Metabolism as related to Photoperiodism" (Chronica Botanica Co, Waltham, Mass 1948)

[4] Sen Gupta, J C, and Sen, N K, *J Ind Bot Soc*, 26, 41 (1947)

Cortical Zonation and Survival of Chromaffin Cells in Adrenal Autografts

IN the earlier investigations relating to the transplantation of the adrenal gland, which were summarized by Biedl[1], success depended largely upon the preservation of the original blood supply of the gland, and in consequence the organ had to remain in close proximity to its original bed The later work of Ingle and Higgins[2] showed that, when the gland is transferred to distant sites, all except a few cells of the glomerulosa degenerate and that these surviving cells then proliferate and produce a mass of cortical tissue Greep and Deane[3] have shown that the subcapsular cells of the enucleated rat adrenal gland are capable of reforming a complete gland (less medulla) in which the three descriptive zones—glomerulosa, fasciculata and reticularis—can be recognized.

In the present work, a series of twenty adult rabbits and six adult rats have been subjected to a left adrenalectomy The gland is then divided into two parts by a cut at right angles to its long axis and a slice 0 5–1 mm. in thickness removed from the cut face with a razor-blade The medulla and cortex can be readily distinguished in such a slice by the translucency of the former and white opacity of the latter The medulla and cortex are separated as accurately as possible along the cortico-medullary junction, washed in isotonic saline and the medullary portion inserted into the anterior chamber of the left eye

In the rabbit, during the first two weeks, degenerative changes affect some phæochromocytes and some cortical cells—the latter are invariably present as the zona reticularis extends as a series of cords into the medulla and may reach the central vein An occasional mitotic figure is observed in the cortical cells but not in the phæochromocytes The graft is firmly attached to the iris after two weeks and vascularization is well marked by one month In grafts aged two months and older, the cortical cells are more numerous than those of the medulla, and in two aged three and four months a typical peripheral glomerulosa (Fig 1) has been observed which adjoins anastomosing cords of cortical cells, groups of phæochromocytes are scattered throughout the cortical tissue and give a strongly positive chromaffin reaction Both cortex and medulla have been found in all specimens so far examined

To date few rats have been killed for examination, but in those few both cortex and medulla exist in the grafts

The source of the cortical cells is of importance. In taking the grafts, the knife blade was so far as possible kept on the cortico-medullary boundary, and hence the cells are mainly, if not entirely, derived

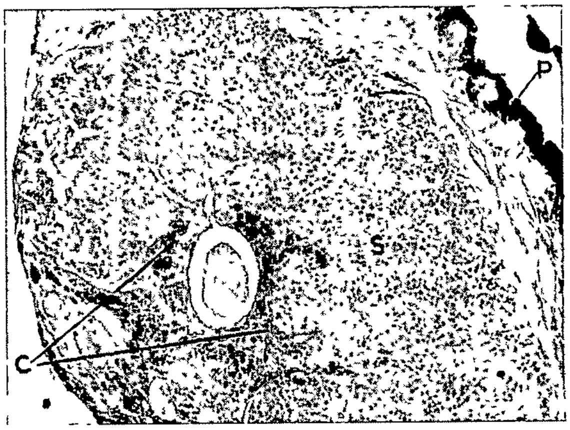


Fig 1 Section through a four-month old graft of rabbit adrenal medulla and associated cortical cells *P*, pigmented layer of iris; *C*, chromaffin cells, *S*, cortical cells

from the zona reticularis , although it is impossible to rule out entirely the presence of an occasional cell from the inner part of the fasciculata, these must at the most be few in number The technique used and method of introduction into the eye precludes the possibility of transferring detached cells of the outer fasciculata or glomerulosa

The proliferation of these inner-zone cortical cells is in keeping with the views of Blackman[4], Yoffey[5] and others, who regard the zona reticularis as a functionally active zone, while the formation of a peripheral glomerulosa in the absence of subcapsular cells supports the views of Jones and Wright[6], who consider that mechanical factors are responsible for the existence of this zone in the Eutherian adrenal cortex • Cortical cells in the graft multiply (as evidenced by mitotic figures), even when the right adrenal is intact , mitotic figures have not, however, been observed in chromaffin cells, and it appears that, although these elements persist, regeneration does not occur

REX E COUPLAND

Department of Anatomy,
University, Leeds
Oct 5

---

[1] Biedl, A , "The Internal Secretory Organs their Physiology and Pathology" (John Bale, Sons and Danielsson, London, 1912)

[2] Ingle, D T , and Higgins, G M , *Endocrinol* , 22, 458 (1938)

[3] Greep, R O , and Deane, H W , *Endocrinol* , 45, 42 (1949)

[4] Blackman, S S , *Johns Hopkins Hosp Bull* , 78, 180 (1946)

[5] Yoffey, J M , "The Suprarenal Cortex" (Butterworth, London, 1953)

[6] Jones, I Chester, and Wright, A , *J Endocrin* , 10, 266 (1954)

A Substance from Eel Serum producing Slow Contractions

EEL serum is well known for its hæmolytic and toxic properties[1] , but so far no report seems to have been published dealing with its effect on isolated organs In the course of investigations into the effects and components of various animal venoms, it was noted that eel serum contained a substance which causes a delayed, slow contraction of the isolated guinea pig ileum and bears some resemblance to the substances producing slow contractions present in wasp venom[2] or appearing in cat plasma after intravenous injection of thalassine[3]

The material possessing this property proved so potent that in most cases it was found impossible to test its effect by applying undiluted serum to a sensitive preparation like the isolated guinea pig ileum suspended in magnesium-free Tyrode solution When eel serum was diluted with 0 75 per cent saline to make a final dilution of 1 10 to 1 50, doses corresponding to as little as 0 002–0 01 ml of the original serum contracted the gut suspended in an organ-bath of 18 ml capacity The contraction began after a typical latency of 10–45 sec and reached its maximum after 60–90 sec It persisted following treatment of the gut with atropine and neoantergane in doses sufficient to suppress strong acetylcholine or histamine contractions, and also remained unaffected after tryptamine desensitization[4] In contrast to the substance present in wasp venom causing slow contraction, repeated doses of eel serum were progressively less active even if the interval between the contractions was extended to 15 min and more , the gut then still responded to histamine in the usual manner.

If eel serum diluted with 0 75 per cent saline was dialysed against distilled water for up to 72 hr , no appreciable activity could be detected in the dialysate, whereas practically all of it could be recovered in the inner compartment, thus indicating that the active component is most probably a large molecule The material producing the slow contraction was little affected by boiling diluted serum at neutral *p*H for 5 min but was destroyed after a few minutes of this procedure in 0 1 *N* sodium hydroxide

Undiluted eel serum caused a contraction of the isolated rat colon resembling that produced by serotonin in very small amounts If all the activity detected by using the rat colon as a test organ is taken as representing serotonin, eel serum would contain about 0 03 µgm serotonin per ml , a figure which is in good agreement with that published by Erspamer and Faustini[5] for extracted eel serum No evidence for histamine occurring in appreciable amounts in eel serum was obtained Small doses of eel serum produced vasoconstriction of long duration in the isolated rabbit ear perfused with Ringer–Locke solution at room temperature

The nature of the material producing slow contraction is being further investigated and a detailed account of this work will be published elsewhere

R. JAQUES

Biological Department,
Ciba, Ltd , Basle
Oct 5

---

[1] Phisalix, M , "Animaux venimeux et venins," 1 (Paris, 1922)

[2] Jaques, R , and Schachter, M , *Brit J Pharmacol* , 9, 53 (1954)

[3] Jaques, R , and Schachter, M , *Brit J Pharmacol* , 9, 49 (1954)

[4] Gaddum, J F , *J Physiol* , 119, 363 (1953)

[5] Erspamer, V , and Faustini, R , *Naturwiss* , 40, 317 (1953)

Spontaneous Microscopic Activity in Cardiac Muscle

WHEN the heart stops beating, pulsations in individual cardiac muscle fibres continue This can be observed by examining thin sections of living cardiac muscle under high-power magnification and transmitted light The pulsations appear to be due to alternate relaxations and contractions of the fibres, with a concomitant change in the width of the striations Under low-power magnification and by reflected light, the activity seen in the isolated mammalian heart is that of spontaneous minute contraction waves Prinzmetal *et al* [1] have noticed a similar though much faster activity in human and dog fibrillating auricles It disappeared with the cessation of fibrillation

These spontaneous minute contraction waves can be observed not only in non-beating hearts but also when the latter beat slowly *in situ* This fact makes it uncertain if the pulsatile activity seen under high-power magnification and the spontaneous minute waves are one and the same phenomenon, and whether the pulsations are present only after cessation of the co-ordinated beat or whether they are a normal accompaniment of the heart-beat

The spontaneous minute waves have been seen in all mammalian hearts so far examined, and their survival-times have been found to vary considerably, the longest seen so far being in rabbit auricles (stored at 4° C) in which they could still be observed six days after isolation

A study of the response of the spontaneous minute waves to changes in environment has shown that they are insensitive to relatively wide fluctuations of temperature.

The appearance of these waves to the eye is much like that of fibrillation in skeletal muscles; but the length of survival and the insensitivity to temperature fluctuations distinguish them from that phenomenon. It may be, however, that the phenomenon is essentially the same in both cases, but that its different characteristics in skeletal and cardiac muscle reflect rather intrinsic differences in these two types of striated muscle. It may be noted that Langley[2] found in cats that fibrillation may last half an hour after the death of the animal and thought this to be remarkably long.

Langley also noted that fibrillation in skeletal muscle is very sensitive to fluctuations of the normal temperature, cessation of fibrillatory activity being very quickly brought about by a fall from body to room temperature. Furthermore, if the spontaneous minute waves are due to fibrillation of the cardiac musculature, it is difficult to conceive how it is that they can be seen in the slowly beating heart, in which no apparent sign of fibrillation can be detected. On the other hand, like fibrillation, the spontaneous minute waves have been found to be sensitive to quinidine and procaine, both of which cause arrest of their activity. Urethane[3] was not found to prolong or increase their activity when drying of the surface film was prevented throughout the period of observation.

The following observations indicate that the spontaneous minute waves are present throughout the myocardium. When the heart is cut into small fragments, they continue their activity uninterruptedly. They are present in both ventricles and atria, and they can be observed on the walls of the chambers of the heart as well as on the outer surface. They are coarser and much more vigorous on the inner surfaces.

It is hoped to publish fuller details of this work elsewhere.

K. HELLMANN

Department of Human Anatomy,
University Museum,
Oxford.
Oct. 11.

[1] Prinzmetal, M., Corday, E., Brill, I. C., Oblath, R. W., and Kruger, H. E., "The Auricular Arrhythmias" (C. C. Thomas, Springfield, Ill.; Blackwell, Oxford, 1953).

[2] Langley, J. N., *J. Physiol.*, 51, 377 (1917).

[3] Hellmann, K., *J. Physiol.*, 120, 41*P* (1953).

Phenolic Substances of Pear–Apple Hybrids

THE leaf of the apple contains as its principal phenolic the glucoside phloridzin. This is present in all *Malus* species examined, together with smaller amounts of the corresponding aglycone phloretin, a quercetin glycoside[1], and traces only of chlorogenic acid and *epi*catechin. Pear leaf, in contrast, contains three phenolics in quantity: chlorogenic and *iso*chlorogenic acids[2] and the glucoside arbutin, with small amounts of catechin, *epi*catechin, flavonol glycosides and hydroquinone, the aglycone of arbutin.

The glucosides phloridzin and arbutin appear to be quite specific in their distribution; in the course of a wide survey of leaves of apple and pear species and varieties by paper chromatography, phloridzin has been found in all apples, but never in pears; conversely, arbutin has been found in all pears but not in apples.

The production of true sexual hybrids between the pear and apple[3] raised the question of the possible dominance of part or all of one phenolic pattern in the hybrid leaf. Through the kindness of the Director of the John Innes Horticultural Institution, it has been possible to examine leaves from a number of different pear–apple hybrids. Because of the limited amount of material available, 70 per cent alcoholic extracts of two-leaf samples were examined by paper chromatography in three different solvent systems; this enabled all the major and some, though not all, of the minor phenolics to be identified.

In all samples, the results indicated addition of the individual phenolic patterns in the hybrids; the leaves contained phloridzin, arbutin, chlorogenic and *iso*chlorogenic acids in quantity, with lesser amounts of phloretin, *epi*catechin and flavonol glycosides. The amounts of each phenolic present varied somewhat among the different hybrids, but in no case were any of the typical phenolics completely absent. In the two triploid hybrids (diploid pear × tetraploid apple), the pear phenolics were relatively weaker than in those hybrids in which both parents were diploid or tetraploid.

This apparently simple addition of the parental phenolic patterns in the hybrids contrasts with the dominant-recessive relationships found with the anthocyanin colouring matters of flowers in intraspecific crosses.

A. H. WILLIAMS

Agricultural Research Council
Unit of Plant Nutrition (Micronutrients),
Long Ashton Research Station,
Bristol.
Oct. 8.

[1] Bradfield, A. E., and Flood, A. E., Rep. E. Malling Res. Sta. for 1949, 103 (1950). Williams, A. H., "Science and Fruit", 210 (University of Bristol, 1953).

[2] Bradfield, A. E., Flood, A. E., Hulme, A. C., and Williams, A. H., *Nature*, 170, 168 (1952).

[3] Crane, M. B., and Marks, E., *Nature*, 170, 1017 (1952).

Growth of *Chondromyces crocatus* in Pure Culture

THE genus *Chondromyces* was named and illustrated, but not described, by Berkeley and Curtis in 1857 in Berkeley's[1] "Introduction to Cryptogamic Botany". It was apparently next seen by Thaxter[2], who reported that he grew it in pure culture. In 1913, this species was stated by Pinoy[3] to grow only in the presence of *Micrococcus*. Beebe[4] reported the presence of *C. crocatus*, but attempts to purify the organism failed completely though it grew readily with various bacteria in mixed culture. Kuhlwein[5] stated that *C. crocatus* could not be grown in pure culture and that it was a symbiotic form. Oetker[6], recently, has shown that several species in the genera *Myxococcus* and *Podangium* can grow upon yeast and algae.

C. crocatus, which may represent the highest morphological and nutritional specialization in the entire order Myxobacteriales, has recently been isolated from soil in our laboratory. The soil sample, obtained in Iowa, consisted of surface debris and soil taken from a permanent bed of rhubarb which, for a number of years, had been heavily fertilized with chicken manure. The organism was found growing on hay agar plates inoculated with a heavy suspension of soil. It grew very slowly and was not observed for almost six weeks after the streak inoculation had been made. Cysts were removed from the cystophores and inoculated at the centre of crossed streaks of *Escherichia coli*, *NRRL B*-281, on hay agar. Growth of the *Chondromyces* proceeded in all directions from the point of inoculation. Repeated re-isolations from the advancing edge of growth yielded a 'pure-mixed' culture of *E. coli* and *C. crocatus*. This technique[7] was recommended by Raper for the purification of new isolates of members of the Acrasiales. In these mixed cultures, vegetative development was particularly good along the streaks of living *E. coli* cells. Between the radiating bands of *E. coli*, where the *Chondromyces* was free of the host cells, growth also occurred. When *Chondromyces* cells from these areas were inoculated on a variety of media, no growth could be obtained. In pure-mixed cultures, abnormal fruiting with very limited cyst formation was found to occur only at the edge of the dish. The presence of chance mould contaminants seemed to promote normal cyst formation.

Interest in the mechanism of lysis of the host cells led us to employ a yeast in which the larger cell-size would facilitate microscopic observations. Hence hay agar plates were inoculated in the above fashion with a culture of *NRRL Y*-1656, *Hansenula anomala*. When these were inoculated with cells free of *E. coli*, as described above, growth occurred which was as good as, or better than, with *E. coli* cells. This is the first report to our knowledge of the growth and lysis of yeast cells by any member of this genus, although Oetker[6] recently reported growth on yeast in two other genera of the Myxobacteriales.

Subsequent studies to be published elsewhere on the nutrition of this organism have shown *C. crocatus* can grow not only on live yeast cells but also may be kept in pure culture on autoclaved cells of yeast. It has been carried through many transfers in pure culture in this manner at 24° C. Growth, although not as good, also occurs on the filtrate from yeast cultures from which all yeast cells are removed. Yeast extract, however, has not supported growth. Solidified vitamin B_{12} assay medium with vitamin B_{12} added also failed to support growth. The factor for growth of *Chondromyces* has been found to be present in liver extract and in large quantities in bovine serum. Purity of the culture of *Chondromyces* was determined by inoculating deep liver broth and various other nutrient media as well as direct microscopic examination. Accepting Thaxter's report of the cultivation of this organism in pure culture as accurate, this communication appears to represent the second report of the growth of *C. crocatus* free of all other living organisms.

C. W. HESSELTINE
DOROTHY I. FENNELL

Northern Utilization Research Branch,
Agricultural Research Service,
United States Department of Agriculture,
Peoria, Illinois.
Oct. 1.

[1] Berkeley, M. J., "Introduction to Cryptogamic Botany", 313 (H. Baillière, London, 1857).
[2] Thaxter, R., *Bot. Gaz.*, **17**, 389 (1892).
[3] Pinoy, E., *C.R. Acad. Sci., Paris*, **157**, 77 (1913).
[4] Beebe, J. M., *Iowa St. Coll. J. Sci.*, **15**, 307 (1941).
[5] Kuhlwein, H., *Arch. f. Mikrob.*, **14**, 678 (1950).
[6] Oetker, H., *Arch. f. Mikrob.*, **19**, 206 (1953).
[7] Raper, K. B., *Quart. Rev. Biol.*, **26**, 169 (1952).

Shape of Bacterial Flagella

IN orthodox bacteriology all flagella are curly. With the exception, however, of spirilla, which possess unchanging horny-looking curly appendages (Fig. 1) directly derived from the cell wall[1], motile bacteria usually go forward with a fuzzy-looking straight tail (Fig. 2) and a twisting body[2]. Under various, probably adverse, conditions this straight tail tends to stiffen into a straight clear-cut rod but more often into a clear-cut helix[3]. The straight tail of Fig. 3 actually became the helix of Fig. 4, and the helix of Fig. 5 also arose from a straight tail. The helices may show two different but characteristic wave-lengths in the same bacterium, one always exactly twice the other as in Figs. 4 and 5, for which phenomenon 'biplicity' would appear a suitable term[3].

The transition from straight tail to helix initially is reversible, but after no matter how many reversals the final shape always is the helix. Normal swimming usually continues during these changes, but after them tends to come to a gradual stop, with the bodies becoming rigid. Often the helices then start whirling movements lasting several minutes. These may push a rigid bacterial body about in erratic fashion, or, if the body has stuck, create maelstroms. This anomalous movement has been mistaken for normal motility and as proof that helices are motor-organs. 'Flagella staining' habitually undertaken at this stage naturally shows curly flagella, and in the disfigured dried material 'biplicity' gets lost.

Figs. 3 and 4 illustrate the recent observation that the transition from straight tail to helix is not accompanied by a change in overall length (measured from free tip to body).

Calculation shows that when a straight tail of 10·75 µ overall length changes into a helix of identical overall length, with five windings of a wave-length of 2·15 µ, and an amplitude of c. 0·35 µ, the real length of the structure becomes c. 12·05 µ, which is an increase of c. 12 per cent. A straight tail of 4·9 µ overall length becoming a helix of five windings of the rather short wave-length of 0·98 µ and an amplitude of c. 0·35 µ changes its real length from 4·9 µ to c. 7·35 µ, an increase of c. 50 per cent. These are values from actual measurements.

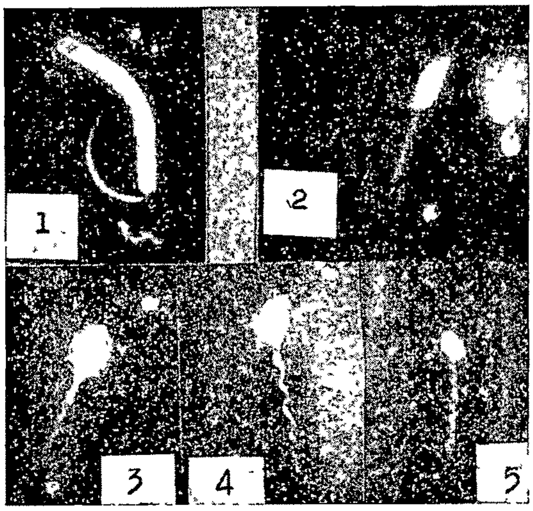


Fig. 1. *Spirillum volutans*. × 1,000
Fig. 2. *Salmonella typhi*. × 1,500
Figs. 3–5. *Salmonella paratyphi B*. × 1,500

How is this helical lengthening brought about? Electron photographs are usually taken at the helical stage and show disorderly masses of submicroscopic wavy fibrils lying around and across bacterial bodies, no straight tail has yet been electron-photographed in the electron microscope.

The transition from straight tail to lengthened helix would seem to necessitate molecular transformations Such helical rearrangements in the tail might well create tensions or liberate forces capable of setting up the anomalous transient whirling movements described above

The helix in some bacteria can be seen to split suddenly into a number of thinner similar helices, these may stay terminal, or float about and become distributed over the surface of their own or other bacterial bodies In this way the so-called monotrichous, lophotrichous and peritrichous types of flagellation are seen to arise Their common origin is the straight tail, the structure primarily associated with normal motility and which therefore seems entitled to some of the attention so far bestowed on its more elegant curly derivatives

These observations were all made with the sunlight dark-ground microscopy described previously[2]

ADRIANUS PIJPER

Institute for Pathology,
University of Pretoria. Nov 10.

---

[1] Pijper, A, Crocker, C G, van der Walt, J P, and Savage, N, *J Bact*, **65**, 628 (1953)

[2] Pijper, A, in "The Nature of the Bacterial Surface" (Blackwell, Oxford, 1949)

[3] Pijper, A, and Abraham, G, *J Gen Microbiol*, **10**, 452 (1954)

[4] Pijper, A, *J Path Bact*, **58**, 325 (1946)

Use of Snail Stomach Cytase in Plant Cytology

DURING a study of the large New Zealand fern genus *Blechnum*, it was found virtually impossible to obtain somatic chromosome counts by orthodox methods This aspect of the problem was about to be abandoned when a paper by Fabergé[1] on the use of snail stomach cytase for maceration in cytology was discovered There appears to be a general lack of knowledge of this method and its advantages Manton[2], for example, makes no mention of it.

Well over a thousand root-tip preparations were made by aceto-carmine squash methods with various modifications, but no really satisfactory results were obtained Fabergé's technique with certain refinements gave outstanding results, almost every preparation yielding good counts (see Fig. 1) Previously adequate spreading had been impossible The method has been applied to other groups of plants and is showing considerable promise

Fabergé mentions the possible use of species of snail other than the edible *Helix pomatia* which he utilized. In New Zealand the only snail available in sufficient quantity is the considerably smaller but cosmopolitan species *Helix aspersa* Mueller With large snails the crop and stomach contents only are used with small specimens, however, these whole organs are removed and pulverized in a little water To the extract from about two dozen snails, about 15 ml of distilled water is added This is followed by centrifuging at 4,000 r p m. for 5 min The clear brown supernatant liquid is then ready for use A sample of enzyme if stored in a refrigerator remains effective for at least three batches of root tips Between uses, any stray cellular material from tissue previously treated must first be removed by centrifuging Preliminary tests have shown that the activity of the enzyme complex has a wide temperature-range The root-tip material is prefixed in a saturated aqueous solution of *p*-dichlorobenzene and then fixed in alcohol – acetic acid (3 1 mixture). Before being placed in the enzyme the root-tips are given two changes of a few minutes each in water Blotting between changes is essential Over-night treatment in cytase at room temperature is satisfactory (or 3–4 hr at 25° C is sufficient) A longer period in cytase tends to make staining more difficult, and the outlines of the chromosomes become diffuse Lengthy treatment may be useful in studies on coiling, as the coils become more apparent. A rinse in tap-water followed by at least a minute in 45 per cent acetic acid assists the aceto-carmine staining

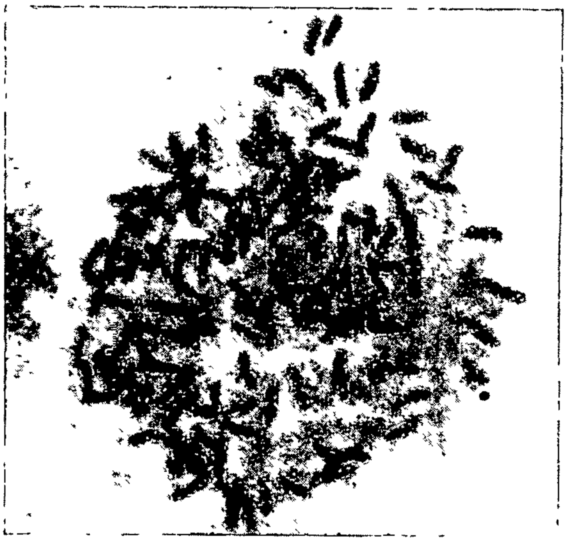


Fig 1 Root tip preparation from a tetraploid race of *Blechnum fluviatile*, somatic number = 132

It is believed that this method has advantages which deserve wider recognition among cytologists

T C CHAMBERS

Botany Department,
Auckland University College,
New Zealand Oct. 6

---

[1] Fabergé, A. C, *Stain Tech*, **20**, 1 (1945)

[2] Manton, I, "Problems of Cytology and Evolution in the Pteridophyta" (Cambridge, 1950)

Selective Fertilization following the Use of Sperm Mixtures in the Mouse

ARTIFICIAL insemination has been carried out in the mouse using mixtures of sperm from a number of inbred lines each containing a suitable genetic marker The lines are *REB* (containing the dominant hair structure gene rex, *ReRe*), *G* (coat colour and pattern tan, a^ta^t), and C_3H (coat colour agouti, *AA*), all possible combinations of these genes are phenotypically distinct in the offspring The first two lines are derived from inbred lines *A* and *CBA* respectively Sperm is obtained from the vas deferens of killed males and the density of each sample estimated by hæmocytometer counts Sperm mixtures were made with equal numbers of spermatozoa from each donor, the donor males for each mixture were of approximately the same age Four types of sperm mixture

Table 1 Total Number of Offspring Born to Date from Mixed-Sperm Inseminations

Males / Females	Sperm mixtures								
	C_3H	*REB*	*G*	C_3H	*REB*	C_3H	*G*	*REB*	*G*
C_3H				24	4	1	2	5	16
REB	10	1	1	22	4				
G	2	0	0			2	4		
X				23	3	13	4	11	10
Total	12	1	1	69	11	16	10	16	26

Table 2 Litter Analysis of C_3H + *REB* Sperm Mixtures

Sperm mixture No	Female	Litters Fertilizing sperm C_3H	*REB*
1	C_3H	4	3
2	C_3H	3	0
3	*REB*	8	2
4	C_3H	2	0
5	*REB*	7	1
	C_3H	5	0
	C_3H	4	0
6	*REB*	5	1
7	*REB*	2	0
8	C_3H	6	1
	X	1	0
	X	0	1
9	*X*	12	2
	X	10	0
Total		69	11

were made, namely, a triple mixture of all three types and three double mixtures containing the three possible pairs of the types These mixtures were used for inseminating œstrous females of the same three lines Since fertility was rather low in the inbred lines[1], the same sperm mixtures have also been used on other females taken from highly fertile non-inbred strains These are referred to as *X* in the tables, which give the results obtained up to the present time

Certain facts are noteworthy in these results First, the mixture of *REB* and C_3H sperm produced a significant excess of eggs fertilized by C_3H sperm This is not due to the death and resorption of the homozygous *REB* animals, because the same result occurs where C_3H are the homozygotes, and also in the non-inbred females The result has been rather consistent throughout the series of nine such sperm mixtures which have been employed (Table 2) Secondly, in the other two double sperm mixtures there is less evidence of unequal efficiency of, or interaction between, sperm types, though the mixture C_3H and *G*, and the small series from the triple mixture, again suggest that C_3H is slightly more effective From the triple mixture one tri-paternal litter has been produced[2], an *REB* female having given birth to a litter of five, three derived from the C_3H sperm and one each from *G* and *REB* sperm

These results clearly show that in sperm mixtures the chance of fertilization by a particular type may not be the same for all components of the mixture At the present stage in the work, several different interpretations of this fact are possible It may be that the C_3H sperm is always more efficient than that of the other two lines involved It may be, however, that the C_3H sperm exerts a specifically depressant effect on *REB* sperm The experiment is so designed that it should be possible to decide between these two possibilities as more numbers accumulate One should, further, be able to discover whether there is any tendency for a reaction of one sperm type either with one particular egg type, or with a particular uterine environment, a possibility which should be borne in mind, though there is as yet little sign of it

This work has been supervised by Dr R A Beatty. I wish to thank Prof C H. Waddington for his interest, and the University of Edinburgh for a postgraduate studentship

R G Edwards

Institute of Animal Genetics,
Edinburgh
Nov 18

---

[1] Snell, D G, Hummel, K P, and Abelmann, W H, *Anat Rec*, **90**, 243 (1944)

[2] Edwards, R G, *Mouse News Letter*, No 11 (1954)

Role of the Nuclei of the Follicle Cells in the Formation of the Chorion in *Cimex lectularius columbarius* Jen.

The follicular epithelium in insects is said to secrete the chorion after the egg is fully formed According to Snodgrass[1], the follicular epithelium secretes a substance which is discharged over the fully formed egg and there hardens to form the chorion Wigglesworth[2] is also of similar opinion. The subject has also been touched upon by Biedermann[3], Cappe de Baillon[4] and Beament[5].

In the course of work on the female reproductive system of the bug *Cimex lectularius columbarius* Jen, collected from the fowl-house of the Indian Veterinary Research Institute, Mukteswar-kumaon, U.P, India, we have found cases in which chorion appeared to be laid down not as an ordinary secretory product of the follicular epithelium, but as something of deeper significance, in which methyl green - staining materials present in the nuclei of the follicular cells were involved.

Ovarioles fixed in Carnoy's fluid and stained with Unna–Pappenheim stain (Fig 1) revealed that the chorion when it was being laid down consisted of three layers an inner layer which took up faint pyronine stain, a middle layer which took up methyl green stain , and an outer layer which showed very faint affinity for pyronine The outer layer sent small spine-like processes outwards, the pointed ends of which were found to be inserted in the nuclei of the follicular cells Globules deeply stained with methyl green were found migrating from the nuclei

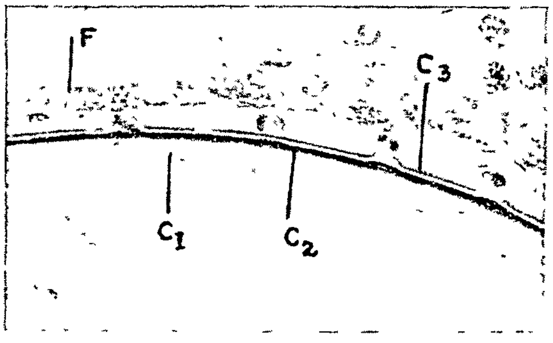


Fig 1 Microphotograph of a part of a section passing through the ovariole of *Cimex lectularius columbarius* Jen, fixed in Carnoy's fluid and stained with Unna–Pappenheim stain × 350 *F*, layer of follicular epithelium C_1, C_2 and C_3, inner, middle and outer layers of chorion respectively Note the globules stained by methyl green in the spine-like processes of the outer layer (C_3)

of the follicular cells through these spine-like processes into the substance of the developing chorion The formation of the chorion in this insect was thus found to be due to the direct intervention of the nuclei of the follicle cells, and in this vital process material staining with methyl green (deoxyribonucleic acid) present in the nuclei of the follicle cells assumed the major role

It is suggested that the whole process of the laying down of the chorion due to nuclear activity is one of short duration, and hence the fixation of the material at the right moment for studying this phenomenon is largely a matter of chance

The spine-like processes through which the material staining with methyl green travels persist on the outer surface of the fully formed chorion It may be noted here that these processes were noticed by Cragg[6] in *Cimex lectularius* and in *Cimex rotundatus* He thought that they served to anchor the egg in position when it was laid

We gratefully acknowledge the award of a research fellowship by the Indian Council of Agricultural Research to one of us (B D)

Added in proof Fresh material has been subjected to the Feulgen technique It was found that the middle layer of the chorion which took up methyl-green stain also gave a strongly positive reaction for deoxyribonucleic acid with this technique The methyl green - staining globules mentioned above were found to be Feulgen positive.

B. Dasgupta
H N Ray

School of Tropical Medicine,
Calcutta
Sept 17

[1] Snodgrass, R E , "Principles of Insect Morphology", 560 (McGraw-Hill, 1935)
[2] Wigglesworth, V B , "Principles of Insect Physiology", 463 (Methuen, 1950)
[3] Beidermann, W , *Winterstein's Handb d vergl Physiol* , 3 (1), 497 (1914)
[4] Cappe de Baillon, *C R Acad Sci* , *Paris*, **196**, 809 (1933)
[5] Beament, J W L , *Proc Roy Soc* , B, **133**, 407 (1946) , *J Exp Biol* , **23**, 213 (1947)
[6] Cragg, F W , *Ind J Med Res* , **8**, 32 (1920)

Rearing Experiments on Marine Teleost Larvæ and Evidence of their Need for Sleep

During a study of the biology of the shore fishes *Blennius pholis* L and *Centronotus gunnellus* (L) several series of experiments have been carried out on the rearing of the larvæ By keeping sufficient eggs in the aquaria it was possible to obtain large numbers of larvæ of similar age These were evenly distributed between bell-jars which each contained 25 litres of sea water and about fifty larvæ It was soon found that mechanical stirring by plunger plates as used by previous workers[1] was accompanied by very heavy mortality of the larvæ The water was therefore kept circulating slowly by gentle streams of small air bubbles The different batches of larvæ were subjected to various conditions of food and illumination Larvæ which died were removed daily and percentage survival was used as criterion for comparison between batches Surviving larvæ grew well, and given suitable conditions a small percentage of these species and of *Cottus scorpius* L were reared until metamorphosis, when they adopted the demersal habit of the adults

It seemed desirable to investigate the nutritional value of phytoplankton cultures, which if suitable would give an easy solution to the problem of providing food Green plant remains have frequently been observed in the stomachs of larval fishes freshly caught from the plankton[2]. Though it has recently been discovered that green pellets found in plaice larvæ from the southern North Sea were fæces of ingested *Oikopleura*[3], it was clearly shown by Gross[4] that herring larvæ kept in the laboratory with cultures of *Chlamydomonas* would fill their guts with green flagellates This was confirmed with larvæ of *B pholis*, *C gunnellus*, *C scorpius* and *Nerophis lumbriciformis* (Pennant)

On examination under a low-power binocular microscope, the young fishes were seen to show a rhythmic peristalsis, which started at the posterior end of the pharynx and travelled posteriorly down the whole length of the narrow œsophagus This swallowing movement was most easily seen in *Centronotus* larvæ, because of their straight gut and slight pigmentation Particles suspended in the sea water were taken in slowly through the open mouth, became arranged in a linear fashion in the narrow œsophagus, and then were forced posteriorly by the peristaltic movements No strong current into the mouth was observed when the fishes were under observation in small dishes , but it seems likely that water is taken in more readily during the course of swimming, for larvæ kept in rearing jars usually had their guts visibly coloured by algal cells, although these were supplied in only moderate concentration

Nevertheless, the large quantities of flagellates and diatoms ingested did not have a markedly beneficial effect upon survival of these larvæ Cultures of *Chromulina pusilla* Butcher, *Isochrysis galbana* Parke, *Chlamydomonas* sp , *Chlorella stigmata* Butcher, and *Prorocentrum micans* Ehrenberg were tried separately in the laboratory with larvæ of *Centronotus*, but the resulting survival-rate was at most only slightly greater than in the larvæ kept without food Similar results were obtained with *B pholis* (Fig 1, *A* and *B*). When these flagellates and diatoms were offered together with nauplii of barnacles and *Artemia*, survival was not significantly better than in larvæ fed on nauplii alone Experiments on these lines are still in progress and it may be possible eventually to demonstrate that phytoplankton organisms have some slight value as food, but it is clearly impossible to rear the larvæ on such organisms alone The ingestion of such organisms is probably connected with the

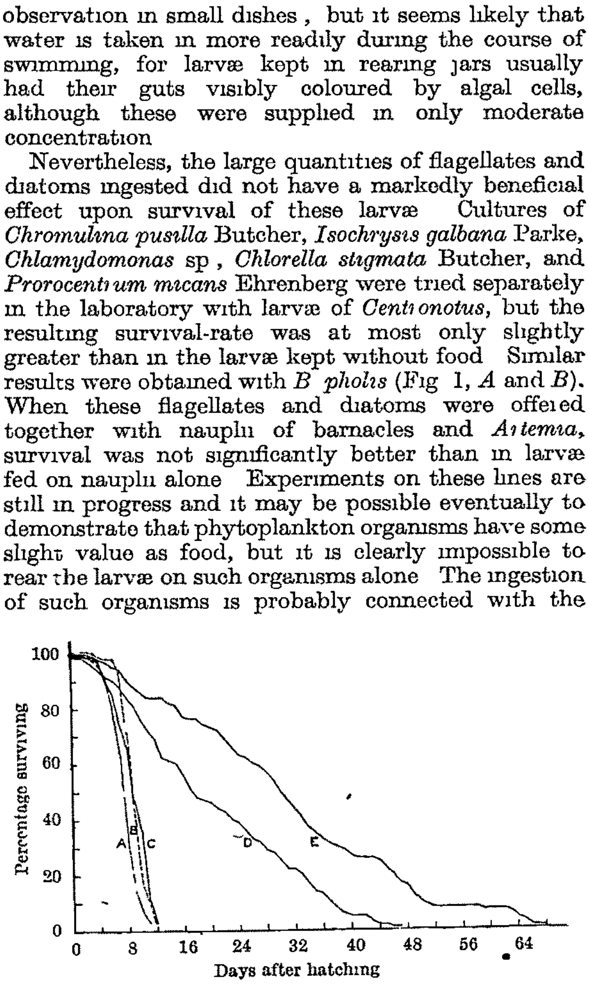


Fig 1 *A*, without food continuous light , *B*, with flagellates, continuous light , *C*, with *Artemia* nauplii, continuous darkness , *D*, with *Artemia* nauplii, continuous light , *E*, with *Artemia* nauplii, alternate light and darkness

drinking of water for osmo-regulation, as demonstrated by Homer Smith[5] in marine teleosts.

Feeding on nauplii, on the other hand, involves deliberate efforts of catching by the larvæ, and they were seen doing this only in the light. Larvæ examined after they had been kept in continuous darkness always had empty stomachs, though they had been supplied with abundant nauplii. Their survival-rate was no more than that of larvæ kept without food (Fig. 1, *A* and *C*). When the only source of illumination was a dim red light, the larvæ of *B. pholis* did not feed but became inactive, and generally remained suspended in the water. Close examination, combined with experiments involving changes of pressure, revealed the presence of a swim bladder with a hydrostatic function, which is absent in adults of this species[6]. The inactivity of the larvæ, which is presumably shown every night, recalled previous accounts of sleeping in fishes[7].

The question of whether such sleep is beneficial was then investigated. Five jars with almost equal numbers of larvæ of *B. pholis* were given 7–8 hr. of illumination during the day and kept in darkness during the night. The same number of jars were kept under continuous illumination. Abundant *Artemia* nauplii were supplied as food to all the jars, particular care being taken to ensure that the larvæ kept under continuous illumination always had plenty of nauplii available as food. Other environmental conditions were equal, and the larvæ were of similar parentage; yet after a few days it was clear that those kept under alternate light and darkness were surviving much better than those under continuous illumination (Fig. 1, *D* and *E*). The rates of survival showed only slight deviations from the mean in all five jars of each batch. After a period of inactivity in the dark, larvæ exposed to light become particularly active, showing more vigorous feeding on nauplii than those kept illuminated all the time.

S. Z. QASIM

Marine Biology Station,
University College of North Wales,
Bangor.
Oct. 5.

---

[1] Garstang, W., *J. Mar. Biol. Assoc. U.K.*, **6**, 70 (1900). Lebour, M. V., *J. Mar. Biol. Assoc. U.K.*, **13**, 721 (1923).

[2] Lebour, M. V., *J. Mar. Biol. Assoc. U.K.*, **11**, 433 (1918); **12**, 22 (1919); **12**, 261 (1920); **12**, 458 (1921). Hardy, A. C., "Fish Invest.", **7**, 1 (1924). Ogilvie, H. S., "Fish. Scot., Sci. Invest.", **1**, 1 (1927). Marshall, S. M., Nicholls, A. G., and Orr, A. P., *J. Mar. Biol. Assoc. U.K.*, **22**, 245 (1937).

[3] Shelbourne, J. E., *J. Mar. Biol. Assoc. U.K.*, **32**, 149 (1953).

[4] Gross, F., *J. Mar. Biol. Assoc. U.K.*, **21**, 753 (1937).

[5] Smith, H. W., *Amer. J. Physiol.*, **93**, 480 (1930).

[6] Plattner, W., *Rev. suisse Zool.*, **48**, 201 (1914).

[7] Boulenger, G. A., and Bridge, T. W., "Camb. Nat. Hist.", **7**, 637 (1910).

Population Regulation in Rabbit Nematodes

COMPARATIVELY little information is available on the factors governing the size of nematode infestations in wild mammals. Elton *et al.*[1] showed that infestations of *Nematospiroides dubius* in field-mice (*Apodemus*) tended to become larger as the host increased in weight, and Evans[2] demonstrated a similar tendency for *Graphidium strigosum* in wild rabbits (*Oryctolagus*), but for *Passalurus ambiguus* he found that, after rabbits reached a weight of 3½ lb., infestations declined with further increase in host-weight. The authors interpreted their results as indicating the effects of increasing age of host. Recent work on the parasites of the wild rabbit (*Oryctolagus cuniculus* L.) in New Zealand gives confirmation of Evans's results for *G. strigosum*, and provides the first adequate picture of population-size in *Trichostrongylus retortaeformis*, a picture which differs markedly from those of the other nematodes mentioned above and forms the subject of the present communication.

The size of worm populations was estimated by a dilution-sampling technique[3]; the presence or absence of infective larvæ in the sample was noted, but all later stages were counted. The paunched weight of the host is used as an indication of age, but as such it is only reliable for rabbits weighing less than 1,000 gm., all such animals being less than 9½ months old[4]. Heavier weight groups contain individuals of varying age; but the proportion of animals more than 9½ months old increases with weight, so that there is an increase in the mean age of the sample in each successive weight-group.

Fig. 1 shows the frequency of occurrence of infestations of different size of *T. retortaeformis* in relation to the paunched weight of the host. The results were obtained from the examination of 1,055 rabbits collected over a period of 13 months (March 1950–March 1951 inclusive) in the Tikokino district of Hawke's Bay Province (North Island of New Zealand). The figures for size of infestation represent one-tenth of the total population (the proportion actually counted), and have been grouped on a logarithmic scale because the range of variation is rather wide.

The most striking feature is the very great range in the size of infestations, and this is evident in every

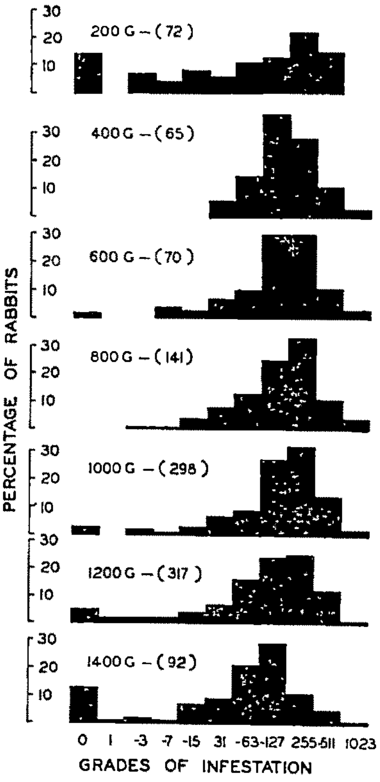


Fig. 1. Frequency of occurrence of different-sized infestations of *T. retortaeformis* in relation to host weight. Figures for size of infestation are grouped on a logarithmic scale. The figures in brackets refer to the number of rabbits in each 200-gm. weight-group, starting from a paunched weight of 200 gm.

weight-group except the second one (400–599 gm), which is based on a slightly smaller sample than the others Heavy infestations were found in some rabbits in every weight class, the largest number of worms counted in one rabbit (paunched weight 1,156 gm) being 937, which indicates a total population of some nine or ten thousand worms The proportion of heavy infestations rises abruptly from the first to the second weight-group, due presumably to the greater chance of acquiring worms as the young rabbits change their diet from milk to grass After this point there is little further increase but, on the contrary, a tendency for light infestations to reappear These facts suggest that heavy infestations are acquired quite early in the life of the rabbit and that there is some mechanism preventing the animal acquiring progressively heavier infestations as it grows older A second point of interest in Fig 1 is that light infestations become increasingly frequent in the heavier rabbits until, in the 1,400 gm weight-class, 12 per cent of the animals had no worms other than infective larvæ

The data presented are probably adequate to give a true picture of *T. retortaeformis* infestations in Hawke's Bay rabbits during 1950–51, but there is evidence suggesting that in some circumstances much higher infestations may occur For example, among 74 rabbits collected at the Auckland Islands (200 miles south of New Zealand) in March 1954, seven had populations exceeding any recorded in Hawke's Bay The largest number of worms counted in one rabbit was 1,920, which is double the highest Hawke's Bay figure The tendency towards a higher proportion of light infestations among the heavier rabbits was even more marked in the Auckland Islands than in Hawke's Bay.

The 'self-cure' mechanism described by Michel[5] for *T retortaeformis* in laboratory rabbits provides a satisfactory explanation for the fact that in most of the classes (Fig. 1) some rabbits contain no worms other than infective larvæ The alternative explanation that the wide range in the size of infestations is matched by an equally wide range in natural resistance among individual rabbits appears less likely, and lacks any experimental support Accepting the 'self-cure' mechanism, and comparing the infestations found in Hawke's Bay with those at Auckland Islands, it is apparent that 'self-cure' may operate at different levels of worm infestation in different rabbit populations This conclusion leads to the suggestion that the abundance of *T retortaeformis* is governed by the resistance of the host, which in turn may be modified by various environmental factors such as the host's food supply[6]. Thus any effect the parasite may have in controlling the numbers of the host is secondary and perhaps additional to that of the environment

Elton *et al* [1] concluded that, since the highest infestations of *N. dubius* occurred in the oldest mice, any increase in the host population by reproduction, and thus a lowering of the average age, causes a reduction in the mean number of parasites per host, thereby reducing the possibility of the parasite acting as a check to the further increase of the host population The present work shows that such a concept would be applicable to *G. strigosum* in rabbits, but not to *T. retortaeformis*, severe infestations of which are common in quite young rabbits

A final conclusion emerging from the present work is that, since abundance of parasites is strongly correlated with age of host (*G strigosum*) and locality of collection (*T retortaeformis*), records of parasite abundance in wild animals are of little significance unless linked with details of age composition and locality of collection of the host sample.

The observations on which this communication is based, together with comparable material on other rabbit parasites, will be published in full elsewhere.

P C BULL

Animal Ecology Section,
Department of Scientific and Industrial Research,
Wellington, New Zealand

Sept. 22

[1] Elton, C , Ford, E B , Baker, J R , and Gardner, A D , *Proc Zool Soc Lond*, 657 (1931)
[2] Evans W M R , *Parasitology*, 32, 67 (1940)
[3] Bull, P C , *N Z J Sci Tech* , B, 34, 341 (1953)
[4] Watson, J S , and Tyndale-Biscoe, C H , *N Z J Sci Tech* , B, 34, 427 (1953)
[5] Michel, J F , *Nature*, 169, 933 (1952)
[6] Stewart, D F , and Gordon, H McL , *Aust J Agric Res* , 4, 340 (1953)

Absorption Spectrum of Deeply Coloured *Cyclo*pentadiene Polymers

*Cyclo*pentadiene can be converted, catalytically by trichloroacetic acid (H*A*), into a brown-red poly-*cyclo*pentadiene trichloroacetic acid ester (I) The colour of this adduct is due to conjugated double bonds[1], which are also responsible for its proton acceptor properties[2], namely, for the fast reversible reaction

$$(\text{I}) + (\text{H}A) \rightleftharpoons (\text{II}), \qquad (1)$$

where (II) is a blue salt-like adduct, formed by transfer of a proton from (H*A*) to (I)

We have developed a technique by which the conversion of *cyclo*pentadiene into (I) or (II) can be carried out at oxygen pressures less than 10^{-3} mm mercury, and by which the light absorption, in the range 2500–30,000 A., could be measured without admitting oxygen to the reaction mixture Absorption bands of (I) of wave-length greater than 3500 A could not be detected, but (II) has a characteristic spectrum in the visible range as shown by curve (*a*) in Fig 1 , this experiment was carried out at a trichloroacetic acid concentration sufficiently high to

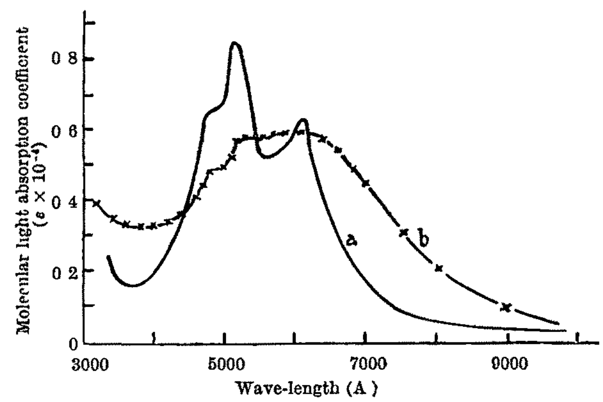


Fig 1. Solvent benzene, temperature 20 0° C , trichloroacetic acid concentration, 1 65 gm mol /l

Curve (*a*), oxygen excluded , measurement carried out 20 hr after start of reaction , polymer concentration, 11 3 × 10^{-4} number average gm mol /l , optical path-length, 0 102 cm

Curve (*b*), ratio of mol oxygen to mol *cyclo*pentadiene at zero time is 1 2 , measurement carried out 24 hr after start of reaction , polymer concentration 6 44 × 10^{-4} number average gm mol /l , optical path-length, 0 205 cm shift the equilibrium of reaction (1) completely to the right-hand side. On addition of oxygen, the spectrum of (II) is fundamentally altered. The various ε-values depend, *inter alia*, on the time of exposure to oxygen and on its partial pressure. The spectrum of oxidized (II), for specified experimental conditions, is shown by curve (*b*). The molar light absorption coefficient, ε, is defined by optical density/optical path-length × *c*, where *c*, the polymer concentration, is calculated from the initial concentration of *cyclo*pentadiene and the number average degree of polymerization specified before[1].

Spectrophotometric tests, in the range 4500–6500 A., were carried out continuously during the conversion of the monomer and it was possible, therefore, to study by an optical method the gradual building up of this coloured polymer. The results of these experiments will be discussed elsewhere.

C. F. Blakely
A. Wassermann

William Ramsay and Ralph Forster Laboratory,
University College,
London, W.C.1.

---

[1] *Nature*, 168, 459 (1951).
[2] *Nature*, 172, 73 (1953).

Mechanism of Osazone Formation

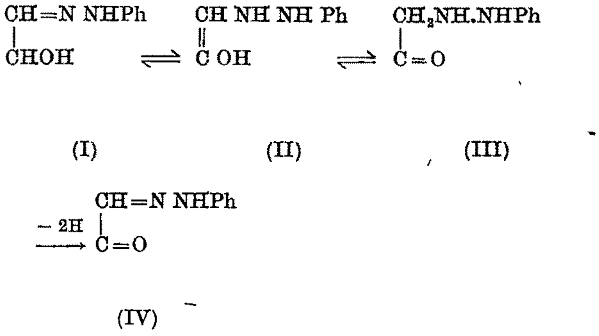
A fact which seems to have escaped attention in formulating a mechanism for osazone formation is that β-alkyl substituted phenylhydrazines are oxidized very readily in air to form phenylhydrazones[1]:

$$R.CH_2\,NH.NH\,Ph \xrightarrow{\text{Air}} R.CH{=}N\,NH\,Ph.$$

Further, it has been found recently[2] that β-acetonyl phenylhydrazine is also oxidized by air at room temperature extremely readily:

$$CH_3.CO.CH_2\,NH\,NH.Ph. \xrightarrow{\text{Air}} CH_3\,CO\,CH{=}N.NH.Ph$$

Here, it seems, is an important clue for detecting the mechanism of osazone formation, since if, as Weygand suggested[3], an Amadori rearrangement (I → III) is assumed



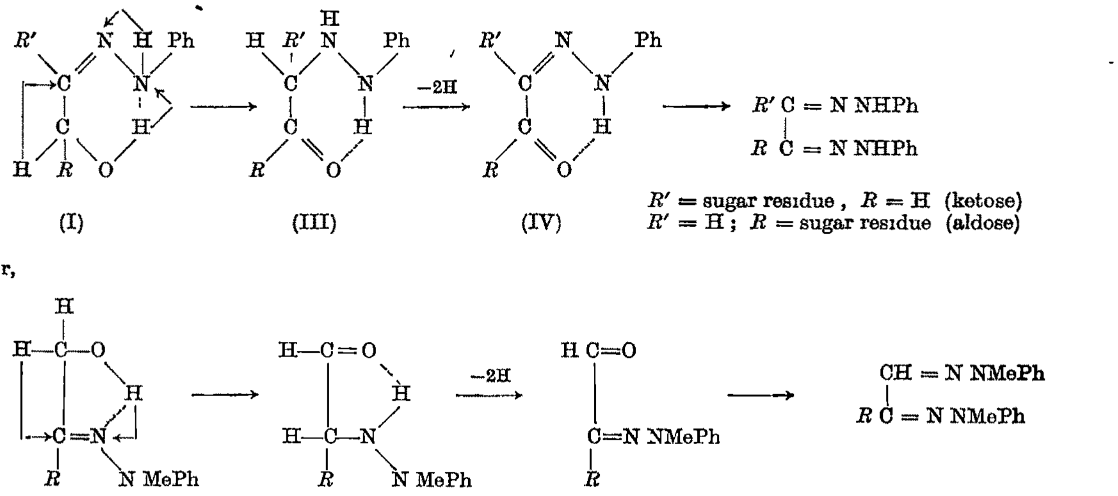
$$\begin{array}{l}CH{=}N\,NHPh\\ |\\ CHOH\end{array} \rightleftharpoons \begin{array}{l}CH\,NH\,NH\,Ph\\ \|\\ C\,OH\end{array} \rightleftharpoons \begin{array}{l}CH_2NH.NHPh\\ |\\ C{=}O\end{array} \xrightarrow{-2H} \begin{array}{l}CH{=}N\,NHPh\\ |\\ C{=}O\end{array}$$

(I) (II) (III) (IV)

then it is no longer necessary to search for an oxidizing agent to convert (III) into (IV). All that is required is a hydrogen acceptor such as oxygen, or the phenyl hydrazonium cation[4], which is reductively cleaved to aniline and ammonia.

This mechanism will accommodate all the known facts on osazone formation, including the observation of Orning and Stempel[5] that the reaction is inhibited at 30° C. in the absence of air. Since oxygen and the phenylhydrazonium cation are competing hydrogen acceptors, one would expect to find a correlation between the yield of aniline (and ammonia) and the quantity of oxygen present.

The formation of osazones and methylphenylosazones may proceed through the hydrogen bonded structures shown below.



R′ = sugar residue, R = H (ketose)
R′ = H; R = sugar residue (aldose)

Two suggestions have been put forward[6] to explain why the reaction is not continued to C_3 of the sugar residue, but a choice between these must await further experimental evidence.

Vincent C. Barry
P. W. D. Mitchell

Laboratories of the
Medical Research Council of Ireland,
Trinity College, Dublin. Sept. 17.

---

[1] Grammatacakis, *C.R. Acad. Sci., Paris*, 204, 1262 (1937); 210, 303 (1940).
[2] Mitchell (in the press).
[3] Weygand, *Ber.*, 73, 1259 (1940).
[4] Kenner and Knight, *Ber.*, 69, 341 (1936). Braude and Forbes, *J. Chem. Soc.*, 1763 (1951). Bloink and Pausacker, *J. Chem. Soc.*, 661 (1952).
[5] Orning and Stempel, *J. Org. Chem.*, 4, 410 (1939).
[6] Percival, "Adv. Carbohydrate Chem.", 3, 43 (1948). Fieser and Fieser, "Organic Chemistry", 351 (D. C. Heath and Co., Boston, 1944).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, February 1

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 1 p m —Mr Donald Wallis "A Critical Review of Some Human Factors in the Design of Machine Controls"

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Dr G E Fogg "The Use of Microscopic Plants in the United States" *

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m —Dr E F Gale "Actions of Antibiotics on Bacteria" * (From a series of lectures on "The Scientific Basis of Medicine")

Society of Chemical Industry, Plastics and Polymer Group (joint meeting with the London Section, at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Dr W C Wake "Surface Chemistry and Adhesion"

Society for Visiting Scientists (at 5 Old Burlington Street, London, W 1), at 7 30 p m —Discussion meeting—"Colour from the Viewpoint of the Painter and the Scientist" Chairman Prof T A Stephenson, F R S ; Speakers Mr G J R Frankl and Prof W D Wright

Wednesday, February 2

Geological Society of London (joint meeting with the Royal Astronomical Society, at Burlington House, Piccadilly, London, W 1), at 5 p m —Discussion on "The Origin of the Earth" Chairman Prof W B R King, F R S Speakers Prof L Hawkes, F R S , Mr T Gold, Prof C E Tilley, F R S , and Sir Edward Bullard, F R S

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 5 30 p m —Continued Discussion on "The Beaver Report of the Committee on Air Pollution"

Society for Analytical Chemistry (in the Lecture Theatre of the Royal Institution, 21 Albemarle Street, London, W 1), at 6 p m — Prof G Schwarzenbach (Zurich University) "The Complexones and their Analytical Application"

University of London (at the Institute of Laryngology and Otology, Royal National Throat, Nose and Ear Hospital, Gray's Inn Road, London, W C 1), at 6 p m —Prof M Arslan (Padua) "The Effects of Ultra Sonic Waves on the Ear" *

Institution of Electrical Engineers, London Students' Section (at Savoy Place, London, W C 2), at 6 30 p m —Mr J Eccles "The Generation of Electricity in Britain"

Royal Institute of Chemistry (joint meeting with the South-West Essex Technical College Chemical Society, at the South-West Essex Technical College, Walthamstow, London, E 17), at 7 p m —Mr L C Nickolls "Some Chemical Aspects of Forensic Science"

Thursday, February 3

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Mr H M Rosenberg "The Thermal Conductivity of Metals at Low Temperatures" , Mr R W Ditchburn "Absorption Coefficients in the Vacuum Ultra-Violet Part 3—Methane"

Linnean Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m —Dr J W S Pringle, F R S "The Evolution of Song in Cicadas"

University of London (at the Institute of Psychiatry, Maudsley Hospital, London, S E 21), at 5 p m —Prof H J Eysenck "Psychology and the Foundations of Psychiatry" *

Physical Society, Acoustics Group (in the Physics Department, Imperial College, Imperial Institute Road, London, S W 7), at 5 30 p m —Prof O K Mawardi "On Heat Maintained Oscillations".

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m —Prof P B Medawar, F R S "Tissue Transplantation Immunity" (From a series of lectures on "The Scientific Basis of Medicine")*

Institute of Metals, London Local Section (at 4 Grosvenor Gardens, London, S W 1), at 6 30 p m —Dr W E Hoare "Tin and Tinplate"

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Scientific Papers

Friday, February 4

Society of Chemical Industry (joint meeting of the Manchester Section and the Food Group, in the Engineers' Club, Albert Square, Manchester 2), at 6 30 p m —Meeting on "Some Aspects of Air Conditioning in the Bakery and Textile Industries"

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 6 30 p m — Dr J A Scott "Health" (From a series of University Extension lectures on "Aspects of Social Policy")

British Glaciological Society (at the School of Geography, Mansfield Road, Oxford), at 8 15 p m —Mr G T Warwick "Ice and Caves"

University of London (at Royal Holloway College, Englefield Green, Surrey), at 8 15 p m —Brigadier Sir John Hunt "The British Mount Everest Expedition 1953"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Prof V B Wigglesworth, F R S "The Control of Metamorphosis in an Insect"

Saturday, February 5

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S E 23), at 3 30 p m —Prof C von Fürer-Haimendorf 'The Sherpas of the Nepal Himalaya" *

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Senior Lecturer (with a degree in agriculture or equivalent qualification and sound experience in practical farming, and, if possible in teaching) in Agriculture at the Cumberland and Westmorland Farm School, Newton Rigg, near Penrith—The Director of Education, 5 Portland Square, Carlisle (February 3)

Head (graduate (preferably science) and with administrative experience) of the Department of Science and General Education—The Principal, London School of Printing and Graphic Arts, Back Hill, London, E C 1 (February 4)

Technician (skilled machinist and/or instrument maker, and preferably with some experience of servicing X-ray therapy equipment) in the Physics Department Workshop—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middlesex (February 4)

Senior Scientific Officer (with a university degree of high standard in electrical engineering or physics, with mathematics or mathematical physics to final honours standard or equivalent qualifications, and several years experience of research in the above or an allied field) in the Department of Supply, Aeronautical Research Laboratories, Fishermen's Bend, Victoria, Australia, to be responsible for the investigation of instrumentation schemes in the field of aeronautical research, and detailed investigation of resultant problems and the subsequent development of necessary apparatus—The Senior Representative (AP 24), Department of Supply, Australia House, Strand, London, W C 2 (February 5)

Botanist (preferably with experience in microscopy) for work connected with the effect of field factors on fruit characters, especially those affecting the storage life of apples—The Secretary, East Malling Research Station, near Maidstone, Kent (February 7)

Assistant Advisors (with an honours degree in anthropology and administrative experience) on Aborigines in the Federation of Malaya —The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 167/60/02 (February 8)

Senior Lecturer (with good qualifications and recent teaching experience, in either physics or chemistry) in Science—The Secretary, Homerton College, Cambridge (February 10)

Senior Lecturer, Grade 1 or 2 (with a good honours degree) in Physics, at the Nigerian College of Arts Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W C 1 (February 14)

Scientists (with a first- or second-class honours degree in physics, engineering, mathematics or statistics, and experience in field, laboratory, or operational research, and preferably with experience in the writing of research reports) in the Field Investigation Group —The National Coal Board, Establishments (Personnel), Hobart House, London, S W 1, quoting TT/914 (February 15)

Lecturer in Animal Production at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (February 17)

Chief Lecturer or Senior Lecturer in Veterinary Clinical Medicine, and a Senior Lecturer or Lecturer (Grade 1) in Veterinary Clinical Medicine, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, February 19)

University Demonstrator in Physics—Dr F B Kipping, Chemical Laboratory, Pembroke Street, Cambridge (February 19)

Headmaster (graduate of a British university and with sound experience of agricultural education) of the Brymore Secondary Technical School of Agriculture, Cannington, near Bridgwater, Somerset—Chief Education Officer, County Education Office, Trull Road, Taunton, Somerset (February 21)

Lecturer in Plant Pathology , a Lecturer/Senior Lecturer in Bacteriology , a Lecturer/Senior Lecturer in Psychology , and a Senior Lecturer in Education, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, February 26)

Reader or Senior Lecturer (with special qualifications in chemical pathology) in Chemical Pathology—The Registrar, The University, Manchester 13 (February 26)

Systematic Botanist (preferably with research interests in quantitative and experimental taxonomy), at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, February 26)

Head (with high qualifications in geology and experience in both teaching and research) of the Department of Geology—The Principal, Chelsea Polytechnic, Manresa Road, London, S W 3 (February 28)

Lecturer in the Department of Logic and Metaphysics — The Secretary, The University, Edinburgh (February 28)

Lecturer (with an honours degree in physiology, and with experience in teaching experimental physiology to honours students) in the Department of Physiology—The Secretary, Bedford College (University of London), Regent's Park, London, N W 1 (February 28)

Senior Lecturer in Physical Chemistry at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (New Zealand, March 1)

I C I Research Fellows (2) in Physics, Chemistry, Pharmacology, Metallurgy, Engineering, Geology or Agricultural Science, or an allied subject—The Registrar, University of Wales, University Registry, Cathays Park, Cardiff (March 31)

Plant and Animal Quarantine Officer (with a university degree with good scientific qualifications and mature experience in the field of plant or animal pests or diseases and their control and prevention, including quarantine measures), with the South Pacific Commission at Noumea, New Caledonia, to carry out investigations, etc , relating to the control of plant and animal pests, diseases, and weeds in the South Pacific, including supervision of a rhinoceros beetle research programme, operation of an information centre and reporting service, and improvement of control and protective measures—The Secretary-General, South Pacific Commission, Noumea, New Caledonia (March 31)

Lecturer (with an honours degree in botany or agricultural botany, and preferably with postgraduate experience in plant physiology, ecology, genetics or virus pathology) in the Department of Agricultural Botany—The Registrar, The University, Reading (April 15)

Turner and Newall Research Fellows in Engineering, Inorganic Chemistry, Physics, and allied subjects—The Registrar, The University, Manchester (April 30)

Agronomist Scientific Officer or Senior Scientific Officer grade (with at least a second-class honours degree with not less than two years appropriate postgraduate experience, preferably including acquaintance with tropical tree crops and up-to-date knowledge of the statistical analysis of field experimental results), at the West African Cocoa Research Institute, to assist in laying down field experiments on various methods of cultivating cocoa—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 197/200/05

Assistant or Associate Professor of Statistics, and a Sessional Lecturer in Mathematics—The Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Alberta, Canada

Chemist or Biochemist (with a good honours degree) in the Technical Division for administrative work which is concerned with the assessment and development of inventions in chemical and biochemical fields—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W 1

Chemist (with two or three years experience in research or industry) for physical and chemical research relating to textile industrial operation—The Personnel Officer, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Ontario, Canada

Deputy Director (with high academic qualifications, wide experience in engineering research, and preferably some administrative ability and a knowledge of the motor industry) of the Motor Industry Research Association—The Director, Motor Industry Research Association, Lindley, near Nuneaton, Warwickshire

Laboratory Steward (with recognized qualifications and with a special interest in physics)—The Registrar, Hatfield Technical College, Roe Green, Hatfield, Herts

Lecturer in Education—The Principal, The Training College, Bingley, Yorks

Physical Chemist (with a good honours degree and some research experience (not necessarily in textiles)), to carry out research on dye absorption by textile materials—The Appointments Officer, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester

Physicists, Chemists, Chemical Engineers and Mechanical Engineers—National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, quoting TT/913

Reader in Physics, and Senior Lecturers or Lecturers (3) in Physics—The Dean, College of Arts and Science, Baghdad, Iraq

Research Assistant to design and construct research electronic equipment and assist in its use—The Director, Chemistry Department, The University, Birmingham 15

Scientific Officers (with a first- or second-class honours degree or equivalent in mathematics, physics or economics), in or near London for operational research under the direction of the Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 384/54A

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

The Registrar General's Statistical Review of England and Wales for the year 1953 Tables Part 1 Medical Pp x+366 (London H M Stationery Office, 1954) 10*s* net [1911

Ministry of Food Domestic Food Consumption and Expenditure, 1952 Annual Report of the National Food Survey Committee Pp 102 (London H M Stationery Office, 1954) 4*s* net [1911

Colonial Office Colonial Road Problems Impressions from Visits to East Africa and Northern Rhodesia By H W W Pollitt (Colonial Research Publications—No 17) Pp vi+77+26 plates (London H M Stationery Office, 1954) 10*s* net [1911

General Register Office Studies on Medical and Population Subjects No 8 Measurement of Morbidity—a Report of the Statistics Sub-Committee of the Registrar General's Advisory Committee on Medical Nomenclature and Statistics Pp iii+12 (London H M Stationery Office, 1954) 1*s* 6*d* net [1911

Federation of British Industries A Career for the Graduate in Industry Pp ii+24 2*s* Industry and the Graduate Pp ii+31 2*s* (London Federation of British Industries, 1954) [1911

Ministry of Agriculture and Fisheries Fishery Investigations Series 2, Vol 18, No 6 The Biology and Dispersal of *Mytilicola intestinalis* Steuer a Copepod Parasite of Mussels By G C Bolster Pp 30+2 plates (London H M Stationery Office, 1954) 5*s* net [1911

Report of the Ministry of Health for the year ended 31st December, 1953 Part 2 On the State of the Public Health—being the Annual Report of the Chief Medical Officer for the year 1953 (Cmd 9307) Pp vi+262 (London H M Stationery Office, 1954) 7*s* 6*d* net [1911

Royal Astronomical Society List of Fellows, Junior Members and Associates, 1954 June List of Persons to whom the Medals or Testimonials of the Society have been Adjudged George Darwin Lecturers Presidents and Officers of the Society Pp 28 (London Royal Astronomical Society, 1954) [1911

Empire Cotton Growing Corporation Progress Reports from Experiment Stations Season 1953–54 Aden Protectorate—Abyan Cotton Experiment Station By R R Anson Pp 5 9*d* Cotton Research Station, Namulonge By J B Hutchinson Pp 8 9*d* Anglo Egyptian Sudan—Cotton Breeding Stations Introductory Note by R L Knight and M F Rose Pp 22 9*d* Kenya—Nyanza Province By M S Hastie Pp 6 9*d* (London Empire Cotton Growing Corporation, 1954) [1911

British Intelligence Objectives Sub-Committee Surveys Report No 34 The German Plastics Industry during the Period 1939–1945 By Dr N J L Megson and H J E Poupard Pp 146+16 plates (London H M Stationery Office 1954) 6*s* net [1911

Report of the Proceedings of the Fourth International Conference on Planned Parenthood, Stockholm, 17–22 August, 1953 Pp xxiii+200 (London International Planned Parenthood Federation, 1954) 10*s* 6*d* , 6 D marks , 900 lire , 2 dollars [1911

Other Countries

Berichte des Deutschen Wetterdienstes Nr 13 (Band 2) Die Optik und Meteorologie der Atmosphärischen Trubung Von Fredrich Volz Pp 47 (Bad Kissingen Deutschen Wetterdienstes, 1954) [1911

Conseil Permanent International pour l'Exploration de la Mer, Charlottenlund Slot, Danemark Rapports et Procès-Verbaux des Réunions Vol 136 (1953) Contributions to Special Scientific Meetings, 1953 Pp 102 (Copenhague Andr Fred Høst et Fils, 1954) 19 kronor [1911

Durban Museum Novitates Vol 4, Part 7 Some Scarabaeina in the Durban Museum and Art Gallery By Maria C Ferreira Pp 91–96 Vol 4, Part 8 Eine Neue Trox-Art aus Sud-Afrika Von Dr E Haaf Pp 97–100 Vol 4 Part 9 Miscellaneous Taxonomic Notes on African Birds By P A Clancey Pp 101–118 (Durban Durban Museum and Art Gallery, 1954) [1911

Thirty-Seventh Annual Report of the National Research Council of Canada, 1953–54, including the Annual Report of Canadian Patents and Development, Limited Pp 50 (N R C No 3286) (Ottawa National Research Council, 1954) [1911

Transactions of the Royal Society of South Australia Vol 77—Centenary Volume Pp xiv+221+4 plates (Adelaide Royal Society of South Australia (Inc), 1954) 42*s* [1911

Bericht uber das Geobotanische Forschungsinstitut Rubel in Zurich fur das Jahr 1953 Von E Rubel and W Ludi Pp 81 (Zurich Geobotanische Forschungsinstitut Rubel in Zurich, 1954) [1911

Memorie dell' Instituto Italiano di Idrobiologia "Dott Marco de Marchi" Vol 8 Pp 322 (Milano Editore Ulrico Hoepli, 1954) [1911

Department of Agriculture, Jamaica Extension Circulars No 50 Caterpillar Outbreaks By Dr H C James Pp 12+1 plate No 51 Keep Your Land Free from Piano Grass By M S Motta, Pp 5 No 52 The Maintenance of Farm Machinery By W K Mitchell Pp 18 No 53 Profitable Production of Corn in Jamaica By C W Hewitt Pp 8 No 54 Care and Management of Bulls By G E Redshaw Pp 13 No 55 Diseases of Rabbits Pp 8 Bulletin No 51 (New Series) Sample Survey of Condensery Supplies, 1951–52 By W D Burrowes Pp 26 1*s* Bulletin No 52 (New Series) Infertility of Cattle in Jamaica a Report on a Visit to Jamaica, September–October, 1952 By S L Hignett Pp i+20 2*s* Annual Report of the Department of Agriculture for the year ended 31st December, 1952 Pp 41 3*s* (Kingston, Jamaica Department of Agriculture, 1953 and 1954) [1911

Bulletin of the American Museum of Natural History Vol 105, Article 1 The Systematic Position of *Lanthanotus* and the Affinities of the Anguinomorphan Lizards By Samuel Brooker McDowell, Jr , and Charles M Bogert Pp 142+16 plates (New York American Museum of Natural History, 1954) 3 dollars [1911

Basket Maker II Sites Near Durango, Colorado By Earl H Morris and Robert F Burgh (Publication 604) Pp x+135+73 plates (Washington, D C Carnegie Institution of Washington, 1954) 4 25 dollars, paper , 4 75 dollars, cloth [1911

Editorial and Publishing Offices of " NATURE "
MACMILLAN & CO , LTD ,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £6, payable in advance,
postage paid to any part of the world

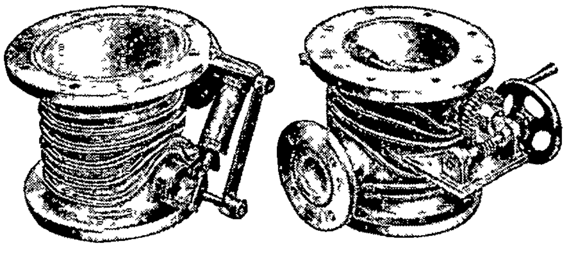
Advertisements only should be addressed to
T G Scott & Son, Ltd , Crown House, 143–147 Regent Street, London, W 1
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

Isolation Valves

FOR HIGH VACUUM PROCESSING

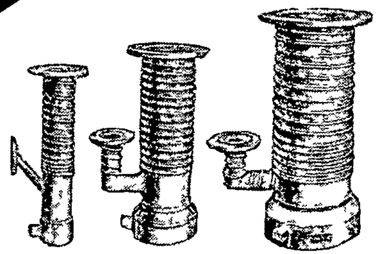
Oil Diffusion Pumps



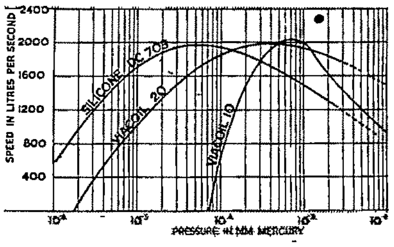
Type V6KA

Type V6K

A complete range of diffusion pumps is available and includes types for the efficient movement of gases and vapours at low pressures with speeds from 50 to 5,000 litres per sec To meet the needs of valving in industrial high vacuum systems, a range of vacuum valves is available Straight through types, right angle types and valves with special bodies are designed for both manual control or automatic operation



Type P4 Type P6 Type P10



Pressure/Speed Graph P10 Mark I Diffusion Pump

VIA-VAC

Specialist Manufacturers of industrial vacuum equipment-consulting service to industry

VACUUM INDUSTRIAL APPLICATIONS LTD, WISHAW LANARKSHIRE

The Policy for Education

provides a means of saving for a child's education. For example, for a parent aged 35 next birthday,

The Society pays

£100 p a. for 5 years, beginning in 15 years' time, and if the parent dies within 15 years, £100 p a in the meantime towards the child's maintenance

The cost is

£8 7s 6d a quarter for 15 years at most

Enquire for details, giving the ages of parent and child

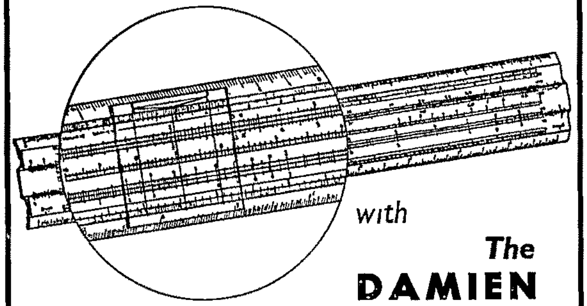
The Equitable Life Assurance Society

(founded 1762)

19, Coleman Street, London, E C 2

No shareholders No commission.

SLIDE RULE EFFICIENCY



with The DAMIEN METAL SLIDE RULE

Light . unbreakable . . never wears out . indifferent to atmospheric or other conditions Photographic printing ensures absolute accuracy, while the silver-grey finish gives figures maximum legibility Retail price £3 3s. 0d each.

SPECIAL REDUCED PRICES FOR OVERSEAS

Obtainable from leading stationers and Drawing Office suppliers or direct from

ANODISED PRODUCTS Ltd.

91 Upper Thames Street, London, E.C.4

Telephone MAN 7765

LECTURES AND COURSES

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

POSTGRADUATE ACADEMIC DIPLOMA IN BACTERIOLOGY

The course for the Postgraduate Diploma in Bacteriology for the Session 1955-56, will commence in October, 1955 This is a full-time day course extending over one academic year The course may be taken by (a) Graduates in Medicine or Veterinary Science desiring to study bacteriology as applied to medicine and hygiene (b) Graduates in science with a first- or second-class honours degree in chemistry, or its equivalent For such students the course covers the fields of general bacteriology, chemical microbiology and industrial microbiology Applications for admission to the Diploma course must be received not later than March 31, 1955

Further information and application forms can be obtained from the Registrar, London School of Hygiene and Tropical Medicine Keppel Street London, W C 1

UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF ELECTRONICS

The Department of Electronics gives an advanced course at honours degree standard in electronics The course is full-time for one academic year and the university grants a diploma by examination to students who successfully complete the course Entry qualification is a university degree in physics or electrical engineering, or its equivalent

The next course will commence in October, 1955, and applications for admission should be made now to the Academic Registrar, from whom further details may be obtained

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

(TECHNICAL OPTICS SECTION)

A course of eight lectures and an accompanying practical course on Thin Film Optics, by Dr W Weinstein will be given on Tuesdays and Thursdays at 4 30 p m, commencing Tuesday, February 22, 1955 Fee for eight lectures, 2 gns, and for practical course 4 gns

For further details apply to the Registry, Imperial College, Prince Consort Road, S W 7

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952

TECHNICIANS FOR NEW ZEALAND DEPARTMENT OF AGRICULTURE

Applications are invited from technicians with experience and recognized qualifications in (a) bacteriology and pathology, (b) chemistry (c) parasitology, for appointment to the Ruakura (Hamilton) and Wallaceville (Wellington) Laboratories of the Animal Research Division and the Rukuhia (Hamilton) Laboratory of the Extension Division of the Department of Agriculture Salary on appointment for applicants with general certificate of education (or equivalent) and six years' experience from £N Z 555 to £N Z 750 according to experience and qualifications An appointing officer from New Zealand will interview suitable applicants in London

Application forms and general information on conditions of employment may be obtained on request from High Commissioner for New Zealand, 415 Strand London, W C 2 quoting reference No 3/4/40, and mentioning this paper Completed applications to be lodged not later than February 26, 1955

EXPERIMENTAL OFFICER REQUIRED BY Ministry of Supply at Royal Aircraft Establishment Farnborough, Hants in a group doing research on metal extraction processes Knowledge of physical chemistry required and metallurgical experience an advantage Qualifications, higher school certificate (science) or equivalent Salary within Experimental Officer range (minimum age 26), £715 to £880 Women somewhat less —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K) Almack House, 26 King Street, London, S W 1, quoting F 19/5A

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

APPOINTMENT OF LECTURER OR SENIOR LECTURER IN THE DEPARTMENT OF APPLIED PHYSICS

The Governing Body invites applications for an appointment as Lecturer or Senior Lecturer in the Department of Applied Physics, with similar title and status in the university The exact status of the successful candidate will be determined by his qualifications, experience and age Candidates should be graduates in physics who have had extensive research experience of solid state physics and preferably of semi-conductors The successful applicant will be expected to devote himself mainly to research and the supervision of research He will be free from administrative responsibilities but will be required to undertake a certain amount of lecturing Under the general supervision of the Professor of Physics he will be required to build up a new section in the Physics Department Hitherto the Department has concentrated most of its efforts in X-ray crystallography, and it is very well equipped for work in this field The new section is to be housed in part of the extension of the College, which will not be finished until next September, nevertheless it would be convenient if the successful candidate could take up his appointment before then so that he could superintend the equipment of his laboratory Salary scale, Lecturer, £650 to £1 350, Senior Lecturer, £1,400 to £1 750, by annual increments of £50 The appointment may be made anywhere within these scales depending on the qualifications and experience of the applicant Superannuation under the F S S U and family allowances

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester, 1 The last day for receipt of applications is March 19, 1955

B V BOWDEN,
Principal of the College

AUSTRALIAN NATIONAL UNIVERSITY

JOHN CURTIN SCHOOL OF MEDICAL RESEARCH

Applications are invited from organic chemists for the position of Research Fellow who will be a research assistant to the Professor of Medical Chemistry Candidates should have a Ph D degree (or equivalent research experience) The successful applicant will undertake full-time research, in laboratories which are well-equipped for the purpose, on the synthesis of new heterocyclic compounds, in particular pteridines, pyrimidines and purines The appointment will be for one, two or three years in the first instance, and if the appointment is made for a period longer than one year, the successful applicant will later be required to transfer to Canberra with the Department The Department's laboratories are at present located at 183 Euston Road, London, N W 1 The salary range is £1,100 to £1,650, and superannuation will be provided on the F S S U pattern

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth 5 Gordon Square London W C 1 with whom applications close on February 28 1955

UNIVERSITY OF MANCHESTER

I C I FELLOWSHIPS

Applications are invited for the above Research Fellowships, founded by Imperial Chemical Industries Ltd tenable in the University and available for research in chemistry physics and allied subjects—e g, pharmacology, engineering, metallurgy The value of the Fellowships will be within the range of £600 to £900 per annum, according to qualifications and experience

Regulations governing the award of the Fellowships may be obtained from the Registrar the University, Manchester, 13, to whom applications should be sent not later than April 30 1955

THE MEDICAL COLLEGE OF ST BARtholomew's Hospital, West Smithfield, E C 1 Applications are invited for the post of Research Assistant to undertake research on the Physiology of Ageing The appointment to commence as soon as possible Applicants should possess a high honours degree in physiology The salary is on a scale of £700 to £1,000 per annum, the commencing point on the scale depending upon qualifications and experience —Applications which should be received not later than February 7 1955 should be addressed to the Professor of Physiology St Bartholomew's Hospital Medical College Charterhouse Square, E C 1

EAST MALLING RESEARCH STATION

Chemist required for mineral analysis of plants The work entails participation in routine analysis and supervision of assistants Applicants for the post, which may be in the Assistant Experimental Officer or Experimental Officer grade, according to age and experience, should have a higher national certificate in chemistry or equivalent qualification Good experience of modern methods of analysis essential Superannuation under the Ministry of Agriculture scheme

Further particulars and application form may be obtained from the Secretary, East Malling Research Station, near Maidstone, Kent, by whom applications should be received not later than March 5, 1955

EXETER COLLEGE

UNIVERSITY OF OXFORD

The Governing Body of Exeter College proposes to elect in the course of Trinity Term, 1955, to a Staines Medical Research Fellowship to be held from October 1, 1955 The fellowship is offered for research in Oxford in one of the medical sciences, such as anatomy, biochemistry, clinical science pathology, pharmacology, physiology It is tenable for a maximum period of five years and is not renewable The annual stipend will be £500, together with various allowances A candidate for the fellowship must not have exceeded 35 years of age, must be of British birth, and should preferably hold a registrable medical qualification

For further particulars apply to the Rector Exeter College, Oxford

UNIVERSITY OF LEEDS

DEPARTMENT OF PHARMACOLOGY

Applications are invited from medically qualified or non-medically qualified candidates for appointment as Demonstrator in Pharmacology, the salary scales are at present under review but it is expected that they will be such as to enable an appointment to be made for a medically qualified candidate within the range £700 to £900 and for a non-medically qualified candidate within the range £550 to £650 a year

Applications (three copies) stating date of birth qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained), not later than February 26, 1955

CENTRAL RESEARCH ESTABLISHMENT, National Coal Board (at Isleworth, Middlesex) invite applications for the superannuable appointment of a Metallurgist to carry out research on metallurgical problems arising in mining operations Current work includes a study of hard metal tool materials and an examination of the problems of the incendivity of light alloys Good honours degree in metallurgy or equivalent professional qualifications, good knowledge of physical metallurgy and of technology of engineering and constructional materials, including light alloys and/or special steels, are required Appointment will be according to qualifications and experience as either Scientist II (scale £800 by £35 to £1 150 male), or Scientist III (scale £500 by £25 to £950 male) London location allowance of £34 minimum rising to £82 maximum is payable in addition —Write, giving full particulars (in chronological order) of age, education qualifications and experience (with dates), to National Coal Board Establishments (Personnel) Hobart House, Grosvenor Place London, S W 1, marking envelope T T /918 Original testimonials should not be forwarded Closing date February 19 1955

MINISTRY OF AGRICULTURE AND FISHeries Chief Technical Officer The Civil Service Commissioners invite applications from men for this pensionable post in London in the Fertilizers Seeds and Hill Farming Division Age at least 35 on November 1, 1954 Candidates must have a degree in agriculture or a related subject, but candidates with outstanding experience in this field may be admitted without this qualification Experience in organization and staff control and a knowledge of the agricultural lime trade and the technique of the production of lime and ground limestone are essential Knowledge of the fertilizers and seeds trades would be an advantage Inclusive remuneration (including extra duty allowance where payable), £1 420 to £1 558 Starting pay above minimum for exceptionally well-qualified candidate —Particulars and application form from Secretary Civil Service Commission 6 Burlington Gardens London W 1, quoting No 4421/55 Completed application forms to be returned by February 25, 1955

LOTHIANS RIVER PURIFICATION BOARD

Applications are invited for the post of River Inspector for the area of the Board Salary is £1,000 by £50 to £1,250 and the statutory qualifications are corporate membership of the Royal Institute of Chemistry and of the Institute of Sewage Purification Candidates with other appropriate qualifications may be considered The superannuation scheme involves medical examination

Applications, giving age, qualifications, appointments held (with dates and salaries), along with testimonials should reach the Clerk Lothians River Purification Board, City Chambers, High Street, Edinburgh, 1, not later than February 28, 1955

J STORRAR,
Clerk of the Board

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston, Berks, requires a Chemical Engineer in the grade of a Senior Experimental Officer or Experimental Officer for development and design work on new chemical plants Minimum qualifications are Inter B Sc or higher national certificate in chemistry, chemical engineering or mechanical engineering, but chemical engineering qualifications to degree standard would be preferred Applicants for a Senior Experimental Officer post should have had several years' appropriate experience and be able to make design calculations with also a good knowledge of constructional materials and of engineering detail The salary ranges are Senior Experimental Officer (minimum age normally 35), £1,017 to £1,197 (male) per annum Experimental Officer (minimum age 26), £715 to £880 (male) per annum The successful applicant will be required to join the Authority's Principal Superannuation Scheme to be introduced shortly, and the salary scales quoted will be enhanced to cover contributions Housing will be available within a reasonable period for married officers who live outside the Establishment's transport facilities During this period, lodging allowance may be payable to suitably qualified candidates —Application form from Senior Recruitment Officer, A W R E, Aldermaston, Berks Quote ref A 19/WGE /34

NATIONAL COAL BOARD INVITE APPLICATIONS for superannuable appointments as Scientific Technical Officers Grade III at various collieries throughout the country in the Pneumoconiosis Field Research (a long-term investigation into the incidence of pneumoconiosis among mine workers) Salary scale £400 by £20 to £560 male Residence near the colliery required After training the officer will be posted to the colliery where the duties involve shiftwork and spending up to three days a week underground, investigating and measuring environmental conditions, especially dust concentration The remaining time will be occupied in evaluating samples in the laboratory General certificate of education in a scientific subject, or equivalent qualification required Knowledge of mining industry not essential —Write giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, marking envelope TT/910 Original testimonials should not be forwarded Closing date February 12, 1955

APPLICATIONS ARE INVITED FOR THE post of Assistant Librarian in the joint library of the Grassland Research Institute and the Commonwealth Bureau of Pastures and Field Crops at Hurley, near Maidenhead Applicants should be qualified librarians with some experience in a scientific library Starting salary according to age up to £487 for men and £467 for women at 25 years or over —Application forms, obtainable from Secretary, Grassland Research Institute, Hurley, Berks, to be submitted by February 7, 1955

APPLICATIONS ARE INVITED FROM women holding degree in biology for appointment of Haematological Technician Previous experience in haematology not necessary In first instance appointment will be made in grade of Technician (£450 to £515 per annum) Promotion to the grade of Senior Technician (£540 to £625 per annum) will be made if satisfactory after probationary period of one year Salary and conditions according to Whitley Council —Apply Dr Mills, Royal Berkshire Hospital, Reading

---

McMASTER UNIVERSITY
DEPARTMENT OF CHEMISTRY
GRADUATE ASSISTANTSHIPS

Applications are invited for part-time teaching and Research Assistantships from persons qualified to register in courses leading to the M Sc and Ph D degrees in chemistry Assistantships normally carry a yearly stipend of $1,400 to $1,600 Assistants are required to devote eight to ten hours per week to duties during the academic session (October to April inclusive) and may devote full time to their research during the summer Research is in progress in the following fields mass spectrometry, nuclear chemistry radiochemistry, natural isotopic abundance ratios and their biological and geological significance, isotope effects, organic reaction mechanisms, physical chemistry of high-polymer solutions, isolation and structure of plant alkaloids, biogenesis of the thyroid hormone intermediary metabolism, inorganic analytical methods

Interested persons should write to Dr R P Graham, Chairman of the Department of Chemistry, Hamilton College, McMaster University, Hamilton, Ontario Canada

---

UNIVERSITY OF LIVERPOOL

Applications are invited for the following Fellowships (i) I C I Research Fellowships in Physics, Chemistry, Engineering Metallurgy and Pharmacology, or any related subject, to which some appointments may be made during the current academic year The appointments will date from October 1, 1955 The salary will depend upon qualifications and experience, but will normally be within the range £600 to £900 per annum, together with F S S U benefits and family allowances (ii) Two Leverhulme Postgraduate Fellowships in the Faculty of Science, tenable for one year at a value of £500, renewable for a second year at a value of £550

Applications, three copies, stating the Fellowship applied for age, details of qualifications and experience, publications, research work in progress and completed, and an outline of the proposed field of research, and, in the case of the Leverhulme Fellowships, whether Nationa Service requirements have been fulfilled, together with the names of two referees, should be received not later than March 1, 1955, by the undersigned, from whom further particulars may be obtained (Candidates overseas who find it more convenient to do so may send one copy only by airmail)

STANLEY DUMBELL,
Registrar

EAST MALLING RESEARCH STATION

A vacancy exists in the Biochemistry Section for research on the biochemistry and metabolism of the fruit tree A good honours degree in chemistry, biochemistry, or botany, a sound knowledge of organic chemistry, and a keen interest in the living plant are required with, if possible, postgraduate experience Salary according to age and experience in the Ministry of Agriculture and Fisheries Scientific Officer Grade Superannuation benefits under the F S S U

Further particulars and application form may be obtained from the Secretary, East Malling Research Station, near Maidstone, Kent, by whom applications should be received not later than March 15 1955

MINISTRY OF SUPPLY, RESEARCH Establishment, S E London, requires Physicist to assist in work involving the application of microscope technique including electron microscopy, to metallurgical and explosive properties This post will probably be transferred from S E London to near Sevenoaks, Kent within next two years Qualifications, higher school certificate (Science) or equivalent, but possession of higher national certificate or degree in physics may be an advantage Previous experience in metallography or in the operation and servicing of electron microscopes desirable Salary within Experimental Officer range (minimum age 26) £750 to £920 (London) Women somewhat less —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26, King Street, London S W 1, quoting A8/5A

NATIONAL RESEARCH DEVELOPMENT Corporation requires a Chemist (or Biochemist) with good honours degree for an established post in its Technical Division The work is concerned with assessment and development of inventions in the chemical and biochemical fields, is administrative and not experimental, and involves liaison with laboratories throughout the country, including medical schools, and with industry Good salary, superannuation arrangements —Applications stating age, qualifications, experience, present salary, and names of two referees, to The Secretary, N R D C, 1 Tilney Street, London, W 1

NIGERIAN COLLEGE OF ARTS, SCIENCE, AND TECHNOLOGY

Principal C A Hart, T D, D Sc, Ph D, M I C E, F R I C S

Applications are invited from candidates with good honours degrees for appointment as Senior Lecturer (Grade I or II) in Physics Now in the early stages of development, the College is autonomous, complementary in function to University College, Ibadan, and of comparable status It has branches at Zaria, Ibadan and Enugu Salary scales, including overseas pay Grade I £1 665 to £1,850 per annum, Grade II, £1,360 to £1 630 per annum Grading and initial salary according to experience Post is pensionable, but temporary appointment carrying gratuity and slightly higher salary might be made Furnished house provided, rent £109 to £150 per annum according to salary Free first-class passages, once each way for each tour of service for person appointed and wife either passage allowance or maintenance allowance for up to two children under 18 Seven days leave on full salary for each month's resident service Tours of service ten to eighteen months

Write for further information to Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W C 1 Closing date for applications (six copies), February 14, 1955

SOUTH PACIFIC COMMISSION
PLANT AND ANIMAL QUARANTINE OFFICER

Applications are invited for the post of Plant and Animal Quarantine Officer with the South Pacific Commission The successful applicant will be appointed for a period from two to three years, and will be stationed at the Commission's headquarters in Noumea, New Caledonia The Plant and Animal Quarantine Officer is required to carry out investigations, etc, relating to the control of plant and animal pests, diseases, and weeds in the South Pacific, including supervision of a rhinoceros beetle research programme, operation of an information centre and reporting service, and improvement of control and protective measures Applicants should have a university degree with good scientific qualifications and mature experience in the field of plant or animal pests or diseases and their control and prevention, including quarantine measures Fluency in English and French is very desirable Commencing salary will be determined according to qualifications and experience, but will be not less than £Stg 1 600 plus a post allowance of £Stg 540 (single) or £Stg 901 (married)

Further information obtainable from the Secretary-General, South Pacific Commission, Noumea, New Caledonia, to whom applications, supported by a detailed curriculum-vitae, should be sent by March 31, 1955

EMPIRE COTTON GROWING CORPORATION
POSTGRADUATE STUDENTSHIPS, 1955-56

With a view to subsequent appointment to the overseas staff men who have completed their National Service are invited to apply for Studentships in (i) Applied Genetics and Plant Breeding, (ii) Plant Physiology Training will be at a university or institution in the U K, with grants ranging according to location from £25 to £34 10s a month, plus approved fees and other allowances Starting salary in the Corporation's service is not less than £900 per annum, including cost-of-living allowance, with free housing and passages

Details and application forms from the Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S W 1

THE FURNITURE DEVELOPMENT COUNCIL a Statutory Body established under the Industrial Organization and Development Act 1947 has two vacancies in the Finishing Section of the Research Department (1) To develop simple test methods for finishing materials, particularly lacquers Applicants should possess a degree in a scientific subject and have had some experience in similar test development work preferably on paints or lacquers The successful applicant will require considerable energy and initiative and the ability to work largely on his own responsibility Travel abroad may be necessary (2) To carry out research of a fundamental character into processes used in the finishing of wooden furniture Applicants should possess a good degree in a scientific subject, preferably physics, and also have research experience not necessarily in the paint or lacquer field Salaries for the above posts will be in accordance with qualifications and experience, but will be generous to the right type of man —Applications to the Director, Furniture Development Council 11 Adelphi Terrace, London W C 2

NATIONAL COAL BOARD
DURHAM DIVISION

Applications are invited for a Scientist Grade II, or Scientific Technical Officer Grade I at No 4 Area Laboratory, Bishop Auckland Durham Salary, Scientist II within scale £800 by £35 to £1 150, Scientific Technical Officer I, within scale £765 by £25 to £915 The successful candidate will be required to take charge of the new Area Laboratory under the direction of the Area Chief Scientist

Applications with full details, to the Area Administrative Officer, Area No 4, National Coal Board Durham Division Howlish Offices Coundon Bishop Auckland, Co Durham by February 5

UNIVERSITY COLLEGE OF THE WEST INDIES

Applications are invited for a Research Fellowship in the Department of Chemistry Candidates should be organic chemists with experience of research preferably on natural products The Fellowship which is of the value of between £750 and £1 100 per annum according to qualifications is for one year but may be renewed Paid return passage to Jamaica

Applications (six copies), detailing qualifications and experience and naming three referees to be received by February 15 by Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square London, W C 1 from whom further particulars may be obtained

OPERATIONAL RESEARCH

British European Airways require a Senior Methods Officer to apply operational research techniques to the study of a variety of managerial and operating problems throughout B E A This is a new and progressive appointment offering wide scope for ability Applicants should have a university degree in science or mathematics with a qualification in statistics, and some years in a position of responsibility, preferably in industry Experience of conducting investigations involving statistical analysis essential Starting salary within the range £1,075 to £1 375 per annum according to qualifications and experience Pension scheme Travel concessions —Details of qualifications and experience to Chief Personnel Officer B E A, Keyline House Ruislip, Middlesex quoting reference B8

MINISTRY OF SUPPLY REQUIRES Chemist or Physicist at Research Establishment near Bridgend Glamorgan, for experimental work on the chemical and physical properties and the measurement of performance characteristics of pyrotechnic systems Qualifications higher school certificate (science) or equivalent, but possession of a higher national certificate or a degree in chemistry or physics may be an advantage Some knowledge of electronic equipment desirable The post may be transferred to Horsham, Sussex within next two years Salary within Experimental Officer range (minimum age 26) £715 to £880 Women somewhat less —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K), Almack House 26 King Street London S W 1 quoting F 18/5A Closing date February 19, 1955

MECHANICAL ENGINEERS REQUIRED at Ministry of Supply Headquarters, London to be responsible to head of section for control progress and co-ordination of development contracts sponsored by Guided Weapons (Engineering) Branch and assist in technical planning of some activities of Branch Qualifications, higher school certificate (science) or equivalent but possession of higher national certificate or degree in mechanical engineering may be an advantage Experience in industry desirable Salary within Experimental Officer range (minimum age 26) £750 to £920 per annum (women somewhat less) —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street London, S W 1 quoting C 19/5A Closing date February 19 1955

PHYSICIST OR MATHEMATICIAN REquired at Ministry of Supply Headquarters London to investigate data reduction associated with ballistic instrumentation with a view to improving methods of presentation of results and to introducing methods of analysis applicable to automatic computing machines Qualifications, first- or second-class honours degree in physics or mathematics Salary within Scientific Officer range, £492 10s to £885 Women somewhat less F S S U benefits may be available —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street London, S W 1 quoting A7/5A Closing date February 24, 1955

UNIVERSITY OF CAMBRIDGE
I C I FELLOWSHIPS

Applications are invited for Research Fellowships, value within the range £600 to £900 a year founded by Imperial Chemical Industries Ltd, tenable in the University and available for research in physics chemistry biochemistry engineering metallurgy, pharmacology, chemotherapy or related subjects Applications must be received not later than April 30, 1955

Regulations governing the award of the Fellowships may be obtained from the Secretary-General of the Faculties The Old Schools, Cambridge, to whom all applications should be addressed

COLLEGE OF ARTS AND SCIENCE
BAGHDAD, IRAQ

Applications are invited for the post of Reader and three posts of Senior Lecturer or Lecturer in Physics Term of appointment to commence not later than October 1 1955 Salaries are in the range ID 1 400 to ID 2 400 (1 ID =£1), together with a cost-of-living bonus of at least ID 120 and certain other allowances Passages are paid at beginning and end of contract Annual summer leave is permitted Persons appointed are required to carry on research and to teach candidates for B Sc degree Teaching is in English Climate and conditions are suitable for British families

For further information apply to the undersigned

A A DURI
Dean

UNIVERSITY OF MANCHESTER
TURNER AND NEWALL RESEARCH FELLOWSHIPS

Applications are invited for the above Research Fellowships founded by Messrs Turner and Newall Ltd, tenable in the University and available for research in engineering, inorganic chemistry, physics and allied subjects The value of the Fellowships will be within the range of £600 to £900 per annum according to qualifications and experience

Regulations governing the award of the Fellowships may be obtained from the Registrar, The University Manchester 13 to whom applications should be sent not later than April 30 1955

ENGINEERS AND PHYSICISTS REQUIRED by Ministry of Supply for posts in Instrumentation Section of Royal Aircraft Establishment, Farnborough, Hants (1) Research in techniques and instrumentation for measurement and recording of physical quantities arising from tests in aircraft and missiles An interest in application of physical principles to design of special measuring instruments would be useful (two posts) (2) Research on electronic circuits and equipment for flight test, wind tunnel and allied aeronautical research purposes Qualifications First- or second-class honours degree or equivalent in physics or engineering Some relevant experience may be an advantage Appointments in grade of Scientific Officer within salary range £467 10s to £845 Women somewhat less F S S U benefits may be available —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street, London S W 1, quoting A13/5A

THE UNIVERSITY OF ALBERTA ANnounces the following vacancies in Mathematics (1) Assistant or Associate Professor of Statistics appointment to be effective September 1 1955 starting salary $5 000 or higher, normal increments $250 (2) Sessional Lecturer in Mathematics for eight months from September 1, 1955 at a gross salary of about $3 600, prospect of permanent appointment —Applications including transcript of academic record curriculum vitae, publications names of two references and recent photograph or snapshot to be sent to Walter H Johns Dean Faculty of Arts and Science, University of Alberta, Edmonton, Canada

RESEARCH ASSISTANT (MAN) WANTED as soon as possible for university work on structure of alloys of high melting point The position offers good opportunities for learning high temperature methods The work is arranged so that the man appointed qualifies as an advanced student for the Oxford D Phil degree Requirements First class honours degree in metallurgy, physics or chemistry Salary according to qualifications Applications from overseas cannot be considered and men with second-class honours should not apply unless they have research experience —Applications to Dr W Hume-Rothery, O B E F R S Inorganic Chemistry Laboratory South Parks Road Oxford

SEVERN RIVER BOARD
POLLUTION PREVENTION DEPARTMENT

Applications invited for appointments in the Board s Laboratories (a) Senior Analytical Chemist Salary in A P T Grade V (£750 to £900) according to qualifications and experience Candidates should hold a degree or equivalent qualification Experience in water, sewage, and trade waste analysis desirable but not essential (b) Junior Analytical Chemist Salary in Grade III (£600 to £725) according to qualifications and experience Candidates should hold a degree or equivalent qualification Appointments are subject to national scheme of conditions of service and to Local Government Superannuation Acts, 1937-1953

Applications, stating age qualifications experience and present appointment with copies of not less than two testimonials, should be sent to the Pollution Prevention Officer at the undermentioned address within fourteen days of the appearance of this advertisement

JOHN V MORLEY,
Clerk of the Board

Portland House, Church Street,
Great Malvern Worcestershire

WEST MIDLANDS GAS BOARD
BIRMINGHAM AND DISTRICT DIVISION
ASSISTANT CHEMIST

Candidates who will be required for duty a one of the works in the Birmingham Divisio must have had some years' experience of th chemical control of a large undertaking an should possess a higher national certificate i chemistry or have reached an equivalent standard The salary will be within Grade 7 (£585 to £66 per annum) of the national salary scales for ga staffs The post is pensionable and the success ful candidate may be required to pass a medica examination

Applications stating age personal details quali fications and particulars of training and experi ence together with the names of two referees should be addressed to Mr J E Wakeford Divisional General Manager West Midlands Ga Board Birmingham and District Division, Ga Offices Edmund Street, Birmingham, 3, to reac him within fifteen days of the appearance of thi advertisement

J C INGRAM
Secretary to the Board

EAST MALLING RESEARCH STATION

Vacancy in the Entomology Section for a mal research worker for studies on Tortricids and lea hoppers associated with tree and bush fruits A really good honours degree, and a keen interes in field entomology are essential research experi ence an advantage Appointment as availabl during 1955 The post will be in the Ministry o Agriculture Scientific Officer grade, carries excel lent research prospects, and is superannuated

Further particulars and application form fron the Secretary, East Malling Research Station nea Maidstone Kent, by whom applications shoul be received not later than April 15 1955

UNIVERSITY OF MANCHESTER

Applications are invited for a full-time post a Reader or Senior Lecturer in Chemical Pathology Candidates need not be medically qualified bu should have special qualifications in chemica pathology Salary scales are (a) for medicall qualified persons Reader £1 800 by £100 t £2 250 Senior Lecturer £1 800 by £100 to £2 000 (b) for non-medically qualified persons Reade £1 250 by £50 to £1 600 Senior Lecturer £1 15 by £50 to £1,500 (salary scales are at presen under review) Initial salary and status accord ing to qualifications and experience Membershi of the F S S U and children s allowance scheme

Applications should be sent not later than Feb ruary 26 1955 to the Registrar, The University Manchester, 13 from whom further particula and forms of application may be obtained

CHESTER BEATTY RESEARCH INSTITUT (Institute of Cancer Research Royal Cance Hospital) Two Technicians required (a) Biochemical technician preferably with experience o manometric techniques or in the isolation o natural products (b) Technician for physical chemistry laboratory for work particularly con cerned with spectroscopic techniques experience in this field would be an advantage Both posts are permanent and superannuable and the salary will be according to age experience and qualifications —Applications marked respectively " Biochemistry " and ' Spectroscopy ' should be addressed to the Chester Beatty Research Institute Fulham Road London S W 3

APPOINTMENTS VACANT

MOTOR INDUSTRY RESEARCH ASSOCIATION

DEPUTY DIRECTOR

Applications are invited for the newly-created st of Deputy Director of the Motor Industry search Association Candidates must have high ademic qualifications, wide experience in engin- ring research and, preferably, some administra- e ability and a knowledge of the motor dustry A salary up to £2,000 per annum will paid to a suitably qualified candidate, and perannuation provided under the F S S U heme

Apply in writing, giving full details of qualifi- tions and experience, to Director, Motor In- stry Research Association, Lindley, near Nun- ton, Warwickshire

DISTILLERS COMPANY LIMITED

The Research and Development Department of the Company have a vacancy for a Mathematician aged 22-26 years for work on a variety of problems concerned largely with instrumentation and physical methods for the study of high polymers Honours degree in mathematics essential, together with some general knowledge of physics, including electronics Salary would depend on qualifications and experience —Apply Staff Manager, The Distillers Co Ltd , 21 St James's Square, London, S W 1 Ref Res 155

WIGGINS TEAPE AND CO, (1919) LTD permakers, require a graduate Chemical En- ieer, age about 35 years preferred, papermaking perience not essential A wood pulp mill in onmouth, S Wales, is being planned for which successful applicant will be required first to ist in the layout, design and building, and n, on completion, to take charge of production Manager —Applicants for this post are asked write in confidence, giving fullest particulars of perience and qualifications, to Chief Personnel icer, Wiggins Teape and Co (1919) Ltd , Ald- e House, Mansell Street, London, E 1

BAYER AGRICULTURE REQUIRE AN EX- ienced Technical Adviser, whose duties will lude liaison with Agricultural Research Insti- es and Colleges and giving advice in the field fungicides, insecticides, and weedkillers nours degree in botany or agriculture and ex- ience in advisory work essential Age 30-40 ary commensurate with qualifications and ex- ience Hotel and travelling expenses reim- sed Staff pension scheme —Write, giving age, ication, experience and salary required, to retary Bayer Agriculture Ltd , Thornycroft use, Smith Square, London, S E 1

RITISH INSULATED CALLENDER'S les Ltd , invite applications for the following ancy at their Leigh Works, near Manchester duate Physicist or Electrical Engineer for the tro-physical Laboratory The work involves study of electrical properties of rubber and hetic insulating materials under a wide range physical conditions Investigational work re- s to the performance of experimental cables odying new and improved designs Candi- s should have an interest in the practical use ll types of electrical measuring equipment but ious industrial experience is not necessary — lications, quoting reference A/26, should be ressed to Staff Officer, B I C C Ltd , Prescot, cs

SSISTANT BIOLOGIST REQUIRED FOR ological work on the deterioration of paper lucts A degree in microbiology or botany chemistry is desirable Salary in range £470 £680 Superannuation (F S S U) Five-day k —Application forms from Printing Packag- and Allied Trades Research Association Ran- s Road, Leatherhead, Surrey (Ref A/BIO 1)

SSISTANT CHEMIST REQUIRED TO in the running of a section devoted to rein- ed plastics Scope for man with initiative practical ability Superannuation scheme — ley Products Ltd , Garman Road, Tottenham, 7

ADY CHEMIST, GRADUATE OR H N C , ired for analysis of electroplating and allied ions —Apply, Electro-Chemical Engineering Ltd , 161 Queens Road Weybridge, Surrey

DISTILLERS COMPANY LIMITED

Applications are invited for the following appointments in the Industrial Group of the Company

SENIOR CHEMIST/CHEMICAL ENGINEER to supervise the operation of the Pilot Plant Division of the Research Department of British Industrial Solvents at Hull The Division includes chemists, chemical engineers several teams of pilot plant operators draughtsmen and a small workshop Age up to 37/38 years A degree in Chemistry or Chemical Engineering is essential, together with a number of years' experience of pilot plant work

ASSISTANT WORKS CHEMIST to undertake control work in the Company's Industrial Alcohol Distillery at Hull Age up to 26 years A degree in Chemistry or equivalent qualification is required, but similar work experience is not essential

ANALYST aged 30-40 years for analytical work in connection with the manufacture of whisky, its by-products and malt extract Duties will include the supervision and training of young chemists in this field A degree in Chemistry or equivalent qualification is necessary and appropriate experience in general analytical and bio-assay work is desirable The post is tenable near Stirling in Scotland

Salaries for the above posts would depend on qualifications and experience Apply Staff Manager, The Distillers Co Ltd , 21 St James's Square, London, S W 1 Ref. DCL/G2

THE PYRETHRUM BOARD OF KENYA require two female Chemists, primarily to assist under Senior Chemists in the analysis of pyrethrum and participation in chemical investigations concerning the industry High degree of accuracy and reliability is required Salary £600 by £20 to £660 then £660 by £25 to £735, plus cost of living allowance, which is at present 10 per cent of the basic salary Post provides for home leave, medical benefit scheme, provident fund, and free air passages Hard furnished flats available Candidates should have had scientific training and experience, preferably possessing a B Sc degree or an intermediate pass, with chemistry as principal subject Candidates without these qualifications, but with a sound scientific grounding will be considered —Write Box JA/112, c/o 95 Bishopsgate, E C 2

RESEARCH SCIENTIST, ENGINEER, OR Mathematician, is required in London by an Operational Research Group in a major industry to study comparative economics of various methods of doing same operation and may be required to lead small team Previous experience of operational research, although desirable, not essential First- or good second-class honours degree in science, engineering or mathematics and some years' experience in research with a good analytical approach and ability to write clear and logical reports is required Salary on appointment depending on qualifications and experience, in scale £858 to £1,232 inclusive —Write, giving full particulars of age, education, qualifications and experience (with dates), quoting this paper, to Box 630, T G Scott and Son, Ltd , 143-147 Regent Street London W 1 Original testimonials should not be forwarded Closing date February 15, 1955

APPLICATIONS ARE INVITED FOR SCIENtific Officers for the British Steel Castings Research Association, Broomgrove Lodge, Sheffield 10 Posts vacant for candidates with either metallurgical or engineering bias to their training Acquaintance with foundry practice a recommendation This Association is building a new experimental station Prospects good for future progress Salary according to qualifications and experience Usual professional qualifications expected

ANALYTICAL CHEMIST REQUIRED BY firm of manufacturing chemists for the control of quality of pharmaceutical products and their raw materials and for the development of analytical processes for the standardization of new products Well equipped laboratory in N W London Commencing salary £750 to £800 Contributory pension scheme —Please address applications which should state age, qualifications experience, etc to Box 633 T G Scott and Son, Ltd 143-147 Regent Street, London, W 1

MULLARD RESEARCH LABORATORIES

invite applications for two types of permanent positions in its Vacuum Physics Laboratory In both cases, the work involves research and development in the realm of semi-conductors, solid state physics and photo devices

(a) SENIOR PHYSICISTS to act as Group Leaders with several years of academic or industrial research experience, preferably, but not necessarily, in the above fields

(b) PHYSICISTS with honours degrees, to work in research and development teams—with or without previous experience

In both cases, the positions offered are progressive and pensionable, and carry attractive salaries Candidates, free of national service obligations, should apply,
quoting reference V P L (J),
to Mr G A Taylor,
Personnel Manager,
Mullard Research Laboratories,
Cross Oak Lane,
Salfords, near Redhill, Surrey

A VACANCY FOR A YOUNG MALE science graduate exists in the laboratories of the Research Association of British Rubber Manufacturers Candidates should possess a pass degree in the physical sciences The person appointed is required to assist in technological investigations in the laboratories and must be prepared to spend time away from the laboratories carrying out investigations in rubber factories The appointment will be initially on the Technical Officer Scale (£475 by £25 to £675), with expectation of promotion to Senior Technical Officer (£600 by £30 to £870) Candidates already having industrial or other experience will be considered appropriately The post would be eminently suitable for someone wishing to familiarize himself with industry and gain experience before taking an executive industrial position —Applications, giving full particulars of age, qualifications and experience, to be sent to the Secretary, RABRM, Shawbury, Shrewsbury, Shropshire

AN ORGANIC CHEMIST IS REQUIRED BY British Schering Manufacturing Laboratories Ltd , Hazel Grove, Cheshire, to take charge of a small Development Laboratory The position would suit a university graduate with two or three years' industrial experience A salary of not less than £700 per annum will be paid, according to qualifications and experience

A PHYSICIST WITH INDUSTRIAL EXPERIence of Instrument development is required to join a small team engaged in the design and manufacture of special-purpose apparatus The work is concerned with a wide variety of physical principles and manufacturing techniques A man possessing a general science degree, preferably including chemistry and with practical experience of mechanical and electrical engineering would be suitable The appointment is at the Applicational Research Centre of a Major Oil Company located near Chester Starting salary according to age, qualifications and experience Attractive pension benefits —Write, giving full details experience, qualifications, age, marital status, to Box ZT 705, Deacon's Advertising, 36 Leadenhall Street, London, E C 3

CHIEF CHEMIST REQUIRED BY FIRM specializing in the rare metals to supervise both routine and research laboratories Ph D or equivalent degree with some industrial experience Commencing salary £1,500 per annum Contributory pension scheme —Box 636, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1

ASSISTANT REQUIRED FOR RESEARCH work in connection with the marine transport of refrigerated cargoes Knowledge of applied physics is required and the work will involve a certain amount of work at various ports Applicants should have a general degree or equivalent and have completed national service Salary will be according to experience within the range £400 to £600 per annum —Apply in writing to Technical Director, Refrigerated Cargo Research Council, Falcon Yard, Cambridge

ENGINEERS and PHYSICISTS

are required by BRITISH TELECOMMUNICATIONS RESEARCH LTD for work on long term research and development projects in the following fields —

(a) Wide-band line communication systems

(b) Wide-band microwave radio systems, including aerials and propagation

(c) Point-to-point television transmission systems

(d) Measuring and testing equipment for the above

(e) Magnetic materials and semiconductors

Attractive posts are offered to qualified engineers with experience in any of the above fields, and further vacancies exist for junior engineers and technical assistants

The Company operates a superannuation scheme, and offers attractive working conditions with generous holiday and leave arrangements, and good social and recreational facilities

All applications will be dealt with in confidence and should be addressed to the Director of Research, British Telecommunications Research Ltd, Taplow Court, Taplow, Bucks

---

JOSEPH LUCAS, LIMITED, HAVE AN INteresting vacancy in their research and development laboratories which would be suitable for a young graduate with honours degree in mathematics or physics The work is largely of a fundamental nature and is concerned with acoustics and mechanical vibrations Previous industrial experience is not necessary —Please reply, giving qualifications, age, and any other relevant details, to Personnel Manager, Joseph Lucas (Electrical) Ltd, Great King Street, Birmingham, quoting reference PM/D/59

THE B T H COMPANY HAVE A vacancy in their Research Laboratory for a Chemist or Physicist to engage in the preparation and processing of silicon for use as a crystal rectifier at ultra-high frequency —Applicants should possess a degree in physics or in chemistry and should write, giving their age and other particulars to the Director of Research, British Thomson-Houston Co, Ltd, Rugby, quoting Reference ATJ

PROFESSIONALLY QUALIFIED ENgineers and Physicists are required to explore and develop new circuits based on transistors —Applicants should write to the Director of Research, British Thomson-Houston Co, Ltd, Rugby, quoting reference BR and stating their age, qualifications and experience

---

THE B T H COMPANY HAVE vacancies in their research laboratory for Assistants in the production, treatment and processing of silicon in very pure form Applicants should have some chemical knowledge and preferably hold a national certificate in chemistry or physics —They should write, giving their age and other particulars to the Director of Research, British Thomson-Houston Co, Ltd, Rugby, quoting reference ON

ENGINEER AGED 25 /35 WITH ELECTRIcal or physicist degree required by Cable Company in London area for development work on testing equipment for telecommunication cables Permanent and pensionable position at salary commensurate with experience and qualifications —Apply, giving full particulars to Box 617, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

SENIOR TECHNICIAN, WITH EXPERIENCE in biochemistry and/or biology required for position of Research Assistant to the Research Manager of a company manufacturing pharmaceutical and medicinal preparations The post is a responsible one, and calls for a first-rate thorough worker, possessing keenness and initiative Contributory pension scheme —Apply to Secretary, Benger's, Limited, Holmes Chapel, Cheshire

---

ENGLISH ELECTRIC CO, LTD, WISH TO extend their present laboratory facilities for study of the effect of environmental conditions on guided weapons and their components Applications are therefore invited from Senior and Junior Engineers to direct and carry out this work A wide variety of electrical, mechanical and physical testing is under consideration, and, although previous experience of guided weapons is desirable, it is by no means essential The possession of an engineering or physics degree, H N C, or similar qualification, coupled with some experience in designing and handling ingenious electrical and mechanical test contrivances, would form a satisfactory qualification Housing assistance can be given if required —Please write, stating age, experience and qualifications, to Dept C P S, 336-7 Strand, W C 2, quoting Ref 1000F

IMPERIAL CHEMICAL INDUSTRIES, DYEstuffs Division, have a vacancy in their laboratories in the Manchester district for a young woman honours graduate who has specialized in biological science, preferably with some experience in microbiology The appointment is concerned with biological control and the manufacture of antibiotics —Applications, giving full particulars of age, qualifications and experience, should be addressed to the Staff Department, Hexagon House, Blackley, Manchester, 9

BRITISH NYLON SPINNERS, LIMITED The Company's expanding activities will give rise to further appointments, during the next few months, covering a wide field of scientific endeavour Graduate Scientists and Textile Technologists, whether available now or later, are invited to register their interest at this stage, and where necessary exploratory interviews will be arranged involving no obligation The openings will cover a range of work including pure research, applied research plant experimentation and the development of new manufacturing techniques up to full scale operation For men with suitable ability and inclinations there will be opportunities for specializing in the new advanced forms of technology arising with the advent of synthetic fibres and their textile applications Several of the appointments will be at a senior level, and the Company will welcome tentative inquiries from chemists, physicists and textile graduates —These will be treated in strict confidence, and should be addressed to the Personnel Manager, British Nylon Spinners, Limited, Pontypool Mon

---

ENGINEER AGED 22/35 REQUIRED BY Cable Company in London area for testing and maintenance of electronic equipment in new instruments for automatic testing of telecommunication cables —Apply, giving full particulars to Box 618, T G Scott and Son Ltd, 143-147 Regent Street London, W 1

APPLICATIONS ARE INVITED FOR POSTS in a development laboratory located in Northamptonshire Minimum qualification required is a degree in physics or the equivalent Experience in microwave work would be advantageous —Box 628, T G Scott and Son Ltd 143-147 Regent Street, London, W 1

UNICAM INSTRUMENTS, LTD

Applications are invited from electron engineers for positions in the develo ment and inspection departments of Unicam I struments of Cambridge This company is e gaged in the manufacture of important instr ments, combining original optical and electron design, which are much in demand for academ and industrial research and process control t world over Good salaries according to quali cations will be paid —Applicants should send f details of age, education and experience, to t Personnel Manager, Unicam Instruments Lt Arbury Works, Cambridge

---

ENGINEER WANTED BY IMPERIA Chemical Industries Ltd, Alkali Division, Wi nington, Northwich, Cheshire, to do research industrial chemical operations such as heat tran fer and matter transfer Candidates aged 25- should possess an honours degree in engineeri (preferably mechanical) and have received su practical training as is required for Assoc Membership of the major Engineering Institutio Starting salary, according to age and experience Applications, giving details of age and experienc should be addressed to Staff Manager

---

BRITISH NYLON SPINNERS LTD, HAV a vacancy in their Library and Information Se tion for a woman graduate in chemistry S will be mainly concerned with assisting membe of the Research and Development Departme in their work by carrying out searches in scienti literature, and with the selection of informati of interest from new material as it is publishe Previous library experience is not essential T appointment is permanent and pensionable —A ply in writing to Personnel Manager Pontypo Mon

---

A PROFESSIONALLY QUALIFIED Engineer or Physicist is required for the development of electrical spark erosion methods as applied to the cutting of hard metals —Applicants should write to the Director of Research, British Thomson-Houston Co, Ltd, Rugby, quoting reference BL, and stating their age, qualifications and experience

---

INDUSTRIAL ORGANIZATION CO cerned with application of photographic proces and apparatus requires a first-class Senior As tant to undertake comprehensive duties in Patent Department Interests are world-wi An extensive knowledge of patent procedures necessary —Write Box 626, T G Scott and S Ltd, 143-147 Regent Street, London, W 1

GRADUATES WITH HONOURS DEgree are required by the BTH Co, Rugby, for research into the physics of light emission from electric discharges and from incandescent surfaces The work will involve radiation measurement and the experimental development of new light sources —Applicants should write to the Director of Research, British Thomson-Houston Co, Ltd, Rugby, giving their age, qualifications and college, quoting reference RH

HONOURS GRADUATES IN PHYSICS Electrical Engineering are required for advan work in a Quartz Crystal Laboratory The p tions offered afford excellent opportunities young men to specialize in the study of pie electric materials from both the theoretical practical view points An interest in mathema and electronics would be an advantage for work Houses can be made available to succ ful applicants —Apply in writing, to the Person Manager, Standard Telephones and Cables L Crystal Division, Industrial Estate East, Harl Essex

---

QUALIFIED ELECTRICAL ENGINEER Physicist required for work on the design utilization of rubber cables for a wide variety applications, mainly for power distribution in mines, aircraft, ships, etc The position of good opportunities for further advancemen Apply Box 632 T G Scott and Son Ltd, 1 147 Regent Street, London, W 1

GRADUATE CHEMIST METALLURG or Chemical Engineer required to deal with pr lems relating to the installation of electropla plant and process control Applicants must h completed military service and be willing to tra —Apply, Electro-Chemical Engineering Co, L 161 Queens Road Weybridge, Surrey

MULLARD RESEARCH LABORATORIES

nvite applications from Scientists to work n its Vacuum Physics Laboratory The osts provide opportunities for physicists or hysical chemists to carry out original re- earch in the field of surface effects in high acuum

Some of the vacancies are for senior cientists with previous research experience n mass spectrometry, gas-solid sorption roblems, or in some allied field

The work offers considerable individual esponsibility and opportunity for original research, and whenever possible, publication is encouraged

Salaries according to age, experience and qualifications Excellent conditions of employment, including contributory pension scheme Apply, quoting reference V P L (R), to Mr G A Taylor, Personnel Manager, Mullard Research Laboratories, Cross Oak Lane Salfords near Redhill Surrey

XCELLENT OPPORTUNITY FOR anic research chemist Successful candidates l take charge of synthetic organic research tion of well known pharmaceutical house in ndon area Thorough knowledge of organic thesis and experience in synthetic drug field ential Position offers great scope Salary mensurate with experience Pension scheme Apply to Box 634, T G Scott and Son, Ltd , -147 Regent Street, London, W 1

AN ELECTRONIC OR ELECTRICAL EN- eer, between the ages of 25 and 35 years, of ree standard is required to take charge of the ineering department of a factory engaged in manufacture of frequency control equipment successful applicant will be responsible for design and specification of all new items as l as routine engineering problems The posi- offers a wide scope for a person possessing necessary technical qualifications and initiative expand the work along numerous channels uses can be made available to successful appli- ts —Apply in writing, to the Personnel Man- r, Standard Telephones and Cables Ltd , stal Factory, Industrial Estate East, Harlow, ex

HARMACEUTICAL RESEARCH CHEMIST well qualified chemist or pharmacist, experi- ed in research methods, is required by London of manufacturing chemists to carry out in- sting research relating to the development of rmaceutical products Postgraduate research erience would be considered an advantage s is a responsible post, carrying a good salary there is a pension scheme —Applications will treated in strictest confidence and should give details of age qualifications and experience ise address to Box 637, T G Scott and Son, 143-147 Regent Street, London, W 1

TATISTICIAN REQUIRED FOR OPERA- al Research into production control problems a large steelworks in the Sheffield area The k involves variance analysis, etc , of machine aviour, set in the study of stochastic processes flow A knowledge of queue theory is desired the ability to handle time series including -correlation The applicant should be inter- d in the Monte Carlo treatment of synthetic a and in such economic developments as game ory, activity analysis and linear programming she will probably hold, or be about to gain degree in mathematical statistics, and should ly in fullest detail (referring to breadth of rests, and stating salary expected) to the Pro- tion Control Officer, Box 629, T G Scott and , Ltd , 143-147 Regent Street, London, W 1

Advertisers please note You must add " Apply Employment Exchange " unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

CHIEF CHEMIST WM MOORHOUSE & Sons Ltd , Sunglow Model Factory, Leeds, require Chief Chemist experienced in Preserves or Food Industry, able to take full analytical and quality control Main specialities Jams, marmalades, lemon curd, Christmas puddings, mincemeat, bottled and canned fruits, jellies This is a senior appointment and carries non-contributory pension —Apply, giving full details present appointment, past record, salary required, etc , to Managing Director All applications treated in strictest confidence

DEVELOPMENT ENGINEERS MARCONI'S Wireless Telegraph Co Ltd , Chelmsford, offer the following appointments to the permanent technical staff of the Company These are well paid responsible positions suitable for applicants possessing design and development experience in the following fields

Ref 2120 AIRCRAFT AERIALS Experimental design and development of H F and V H F Aerials Systems Applicants should have had some experience in this field and preferably be familiar with small scale model techniques

Ref 2130 RADIO LINKS Appointments are in connection with the development of U H F and S H F Wideband Multichannel systems Especially suitable for applicants with a knowledge of travelling wave tubes and centimetric techniques

Ref 2140 MARINE COMMUNICATION AND RADAR Appointments available in connection with the development of marine transmitters, receivers, navigational aids and associated equipment

Ref 2220 T V EQUIPMENT Vacancies exist in connection with the development of cameras, studio equipment, transmitters and associated apparatus

Ref 2240 V H F MOBILE EQUIPMENT Appointments available in connection with the design of mobile transmitters, receivers and associated power supplies

All appointments are in connection with the expansion of activities in the Company and carry excellent career prospects for applicants who are able to make an immediate contribution to the work of the Groups Please write giving full details of qualifications and experience and quoting ref SA 55A and appropriate reference number, to Dept C P S 336/7 Strand, W C 2

PHYSICAL CHEMIST (OR PHYSICIST, with knowledge of analytical methods), to take charge of Works Control Laboratory in Hertfordshire, graduate preferred Initial salary approximately £1,000 per annum (according to qualifications for post) Excellent prospects Pension and profits participation schemes —Write full details age, qualifications, experience to date, to Ref P C Box No 8282, c/o Charles Barker and Sons Ltd , 31 Budge Row, London, E C 4

APLIN AND BARRETT, LTD , REQUIRE A Bacteriologist for their Research Laboratories at Yeovil Applicants should hold a degree in bacteriology and chemistry, and some research experience would be an additional qualification The person appointed would be required to undertake fundamental research in addition to work of a more applied nature Salary according to age qualifications and experience —Applications should be addressed to The Director of Research, Aplin and Barrett, Ltd , Newton Road, Yeovil, Somerset

CHEMISTS AND PHYSICISTS ARE REquired for a petroleum research station near London Candidates should be aged 20-26, with first- or second-class honours degrees, and should have fulfilled national service obligations Previous industrial laboratory experience desirable but not essential Good working conditions, non-contributory pension scheme Salary according to age and qualifications —Write, giving full details and quoting H 3028, to Box 7249, c/o 191 Gresham House, E C 2

GRANTS & SCHOLARSHIPS

THE ROYAL SOCIETY

ROYAL SOCIETY AND NUFFIELD FOUNDATION COMMONWEALTH BURSARIES

Applications are invited for awards under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme which was instituted to provide facilities for increasing the efficiency of scientists of proven worth by enabling them to pursue research, learn techniques or follow other forms of study in natural science in countries other than their own in the Commonwealth where the physical or personal environment or both are peculiarly favourable The bursaries provide travel, maintenance at a rate of about £600 a year, depending on living costs and the applicant's circumstances and are tenable usually for periods of two to twelve months , they are not intended to provide any salary as such Bursars will not be permitted to prepare specifically for, or to take examinations for, higher degrees or diplomas

Fuller particulars and forms of application may be obtained from the Assistant Secretary, The Royal Society, Burlington House, London, W 1 Applications should be made before March 15, 1955, for proposed visits beginning during the period from July to December, 1955

THE COUNCIL OF SOMERVILLE COLlege Oxford, offers a Mary Somerville Research Fellowship, annual value £350, for three years, from October, 1955, with board and, for a maximum of three terms, residence in College —Particulars of the Fellowship which is open to Oxford women only, may be obtained from the Secretary, Somerville College, Oxford Final date for applications March 1 1955

MISCELLANEOUS

MURDOCH TRUST

For the **BENEFIT** of **INDIGENT BACHELORS** and **WIDOWERS** of good character over 55 years of age, who have done " something " in the way of promoting or helping some branch of Science

Donations or pensions may be granted to persons who comply with these conditions

For particulars, apply to MESSRS SHEPHERD & WEDDERBURN, W S , 16 Charlotte Square, Edinburgh, 2

NOTICE IS HEREBY GIVEN THAT ENDEcotts (Filters) Limited seeks leave to amend the complete specification of Letters Patent No 667,924 for an invention entitled " Improvements in or relating to test Sieves " Particulars of the proposed amendments were set forth in the Official Journal (Patents), No 3440, dated January 19, 1955 Any person may give Notice of Opposition to the amendment by leaving Patents Form No 36 at the Patent Office, 25 Southampton Buildings, London, W C 2, on or before February 21 1955

TECHNICAL SERVICES BUREAU SPECIALizes in services to scientific and technical authors Preparing MS for press, indexing, proof-reading, translations, secretarial work —17 Clifford Road, New Barnet, Herts BARnet 4730

ELECTRONICS APPLIED TO INDUSTRY Learn the basic principles and applications with our modern self-study course Experimental work included if required —Free Brochure from E M I Institutes Dept N 56, London W 4 (Associated with H M V)

Secondhand Microscopes

BOUGHT FOR CASH OR TAKEN IN EXCHANGE

CLARKSON'S 338 High Holborn, W C I

Opposite Gray's Inn Road 'Phone HOLborn 2149

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE

FROM LIVER OR YEAST

and other SIGMA 'brand products are now available
Ask for list SIGMA 8

GEORGE T. GURR LTD.
136-138 NEW KINGS RD , LONDON, S W 6
The Microscopical Stain People

"I.D.L." SCINTILLATION COUNTING UNIT TYPE Nº 1653

COMPLETE IN 6 Ft. STANDARD RACK

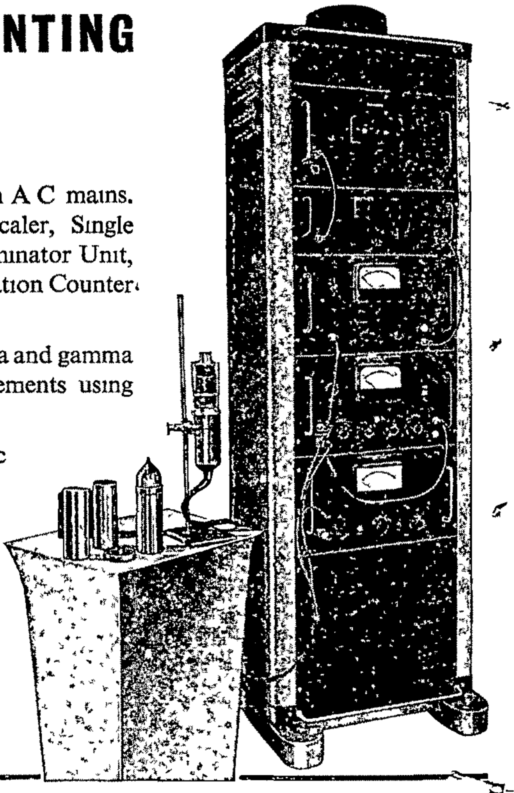
Mounted on castors for use anywhere in the laboratory on A C mains. The complete counting unit consists of Scaler, Prescaler, Single Channel Pulse Analyser, Wide Band Amplifier & Discriminator Unit, Extreme Stability E.H T. Supply Unit, Universal Scintillation Counter Head (with suitable scintillators).

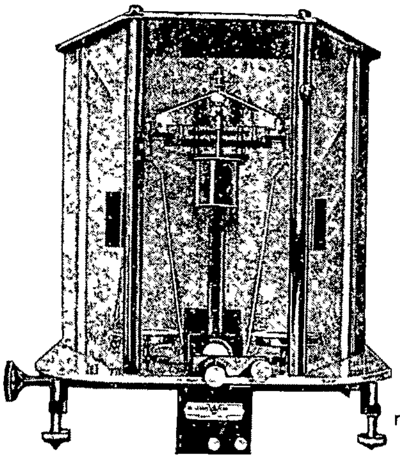
- Complete unit is designed for exacting requirements of beta and gamma ray spectrometry, but is suitable for all count measurements using scintillation, Geiger Muller and other types of detectors

Another addition to our wide range of precision nucleonic laboratory equipment.

Full particulars from **ISOTOPE DEVELOPMENTS LTD.**

Laboratory and Works BEENHAM GRANGE,
ALDERMASTON WHARF, NR READING, BERKS
London Sales Office 120 MOORGATE, LONDON, E C 2
Telephone METropolitan 9641 (5 Lines)





The new Aperiodic Balance, using FLUID Damping

◆

Fast, Positive Settlement

◆

Metal case of modern design

Ask for particulars of the
"CRESTA I"
Aperiodic Balance.

Sole manufacturers

WILLIAM A. WEBB, LTD.
1–9 PERRYMANS FARM ROAD
NEWBURY PARK, ILFORD, ESSEX
who will gladly send details on request

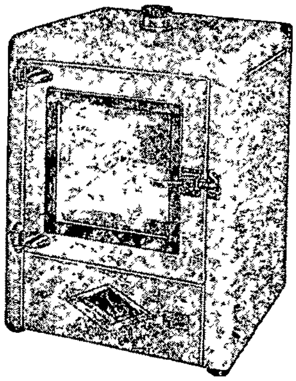
Phone VALentine 6370
Grams Accuracy, Ilford
Cables Accuracy, Ilford

Type F *(With or Without forced circulation)*

Hot Air Oven and Steriliser

STOCKED IN 3 SIZES

All standard LTE equipment is available for one month on test approval



Other LTE Products—

Incubators
Universal Baths.
Soxhlet Heaters
Thermostatic Baths.
Dyepot Baths
Brewer's Mash Baths
"PATRA" Humidity Cabinet

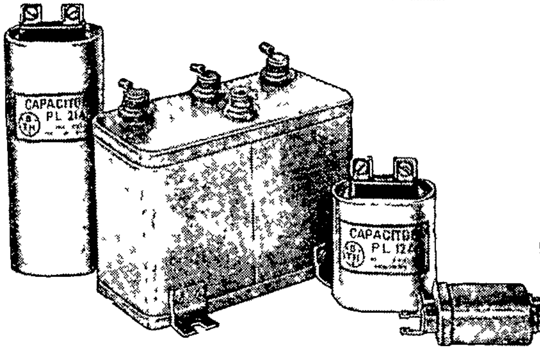
Illustration on request to LTE

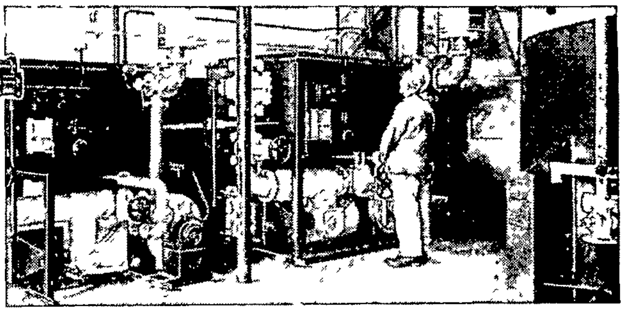
LABORATORY THERMAL EQUIPMENT LTD

GREENFIELD, NR OLDHAM, ENGLAND
Telephone Saddleworth 552

DRY AIR FOR IMPROVED VACUUM WORK

Thorough insulation impregnation by alternate vacuum and pressure cycles demands the rigid exclusion of moisture from the system by BIRLEC LECTRODRYERS BIRLEC LECTRODRYERS are applicable to a number of electrical applications including the dry blanketing of transformers during assembly, the dry storage of delicate components and insulating material and the drying of gases for lamp filling, electrode annealing etc





A selection of capacitors for fluorescent lighting equipment and ignition units which are vacuum impregnated faster and better by the installation of a Birlec Lectrodryer (Right) Two special Lectrodryers designed for working in conjunction with an insulating impregnation tank
Both photographs are published by kind permission of the British Thomson-Houston Co Ltd

Please send me details of LECTRODRYERS for electrical work

Application

Name

Company

IVW

sm/B 2131 54

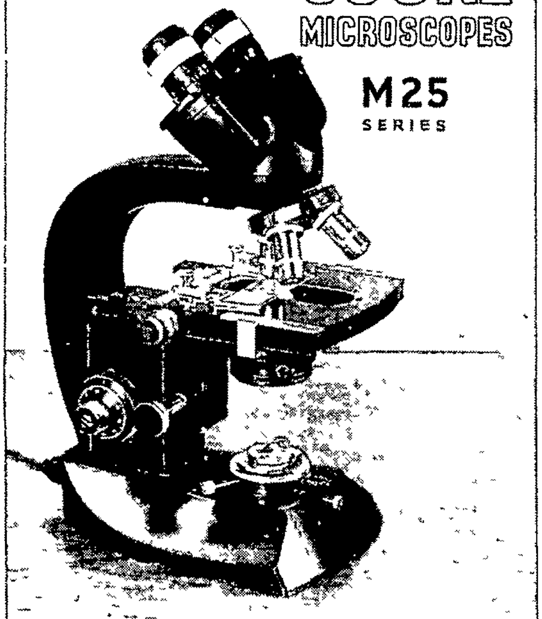
DRYER DIVISION OF
BIRLEC LTD

BIRLEC

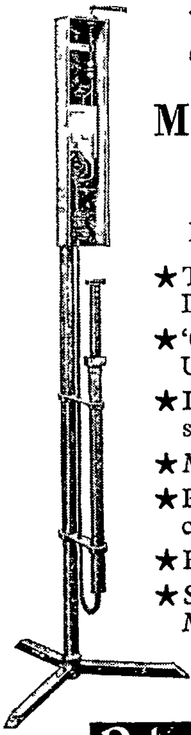
ERDINGTON
BIRMINGHAM 24

Member of the AEI Group of Companies

COOKE
MICROSCOPES
M25
SERIES



Cooke Troughton & Simms LTD
YORK, ENGLAND



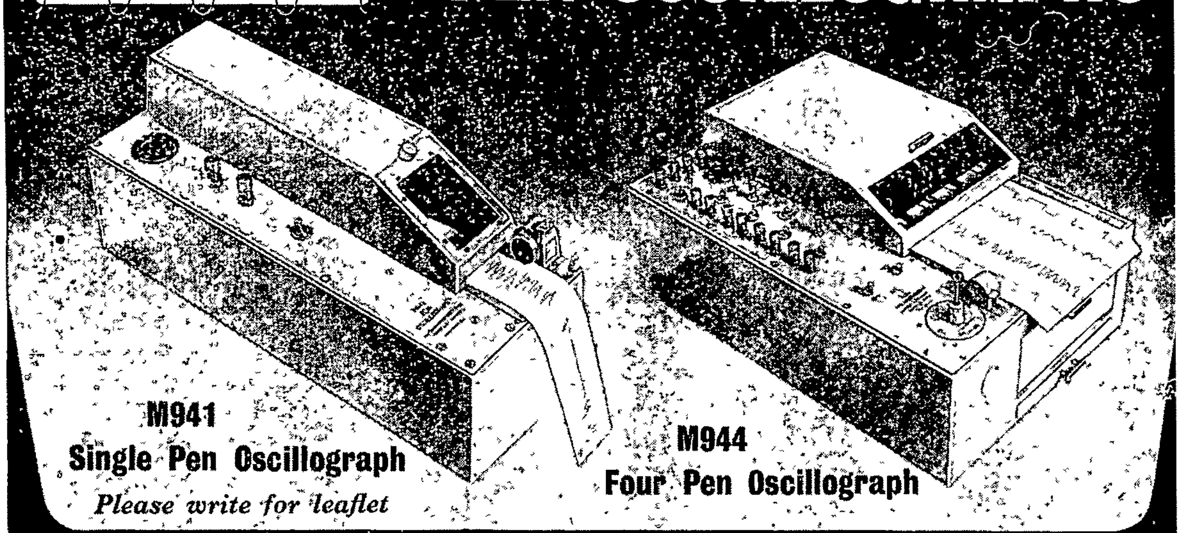
Pulsometer
Trade Mark
McLEOD GAUGE
TYPE "G"
with
REPLACEABLE HEAD

★ The only breakable part is the Demountable standard Head
★ 'O' Ring Sealed Vacuum Unions.
★ Lightweight but rigid construction. All Metal Frame.
★ Metal Barometric Tube
★ Plunger operated giving fine control and easy operation.
★ Hard Gloss Finish.
★ Standard Ranges .1— 00001 M/M. 10— 01 M/M.

Advertisement No 3370

Pulsometer Engineering C° L^d.
Nine Elms Ironworks, Reading.

MINIRACK PEN OSCILLOGRAPHS



Please write for leaflet

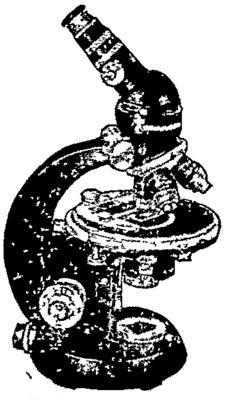
SOUTHERN INSTRUMENTS LIMITED
CAMBERLEY SURREY

Telephone: Camberley 2230 (3 lines) Telegraphic Address: "Minrak, Camberley, England"

ZEISS WINKEL

Polarising Microscope

The refinements of the Winkel Standard design, the built-in illumination, the precision and safety device of the objectives are made available for users of polarising microscopes. A full range of accessories is available



Full details from
DEGENHARDT & CO., LTD.
32 MADDOX STREET, LONDON, W 1
Telephone MAYfair 6639
SOLE IMPORTERS FOR GT BRITAIN & N IRELAND

PHOTOMICROGRAPHY

SIMPL LTD. is fully equipped to undertak all branches of photomicrography for research and industry

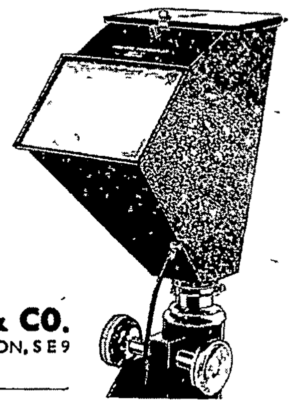
Prints, lantern slides, colour prints and tran parencies

SIMPL LIMITED, 1–4 LAMBETH HIGH ST, LONDON, SE

• **Individually Tested and Guaranteed** •
(A E R E Harwell approved)
HIGH VACUUM STOPCOCKS
New Catalogue on request to
G. SPRINGHAM & CO. Harlow New Town
"The Stopcock People" HARLOW 24108

Use a Golder
MICROFLEX
Eyepiece Camera
for your photomicrographic records
PRICE £10.10s.

Send for leaflet M8 containing further information from
ALBERT GOLDER & CO.
137 DAIRSIE RD, ELTHAM, LONDON, S E 9
Phone ELTham 5126
Trade supplied



NATURE

THE LEADING INTERNATIONAL JOURNAL OF SCIENCE

Published Weekly Two Shillings

★

"NATURE" surveys the whole field of pure and applied science, and is authoritative and topical. It is read by scientific workers all over the world.

★

Every issue includes

A LEADING ARTICLE—on science in relation to modern life and public affairs.
REVIEWS—each by an authority on the subject discussed.
GENERAL ARTICLES—surveying new discoveries and developments.
NEWS and VIEWS—on current topics and events.
DESCRIPTIVE REPORTS—of scientific meetings.
LETTERS TO THE EDITORS and SPECIAL ARTICLES—in which scientific workers of all countries of the world describe their current investigations.

A classified list of recent Scientific and Technical Books is included each month.

★

The charges for direct postal subscriptions, postage paid to any part of the world, are

12 months	£6 0 0
6 months (26 issues)	£3 0 0
3 months (13 issues)	£1 10 0

Please send me "NATURE" for .... months, beginning with the issue for ....

for which I enclose remittance value ....

Name ....

Address ....

....

....

Date............................

MACMILLAN & CO. LTD., St. Martin's Street, London, W.C.2

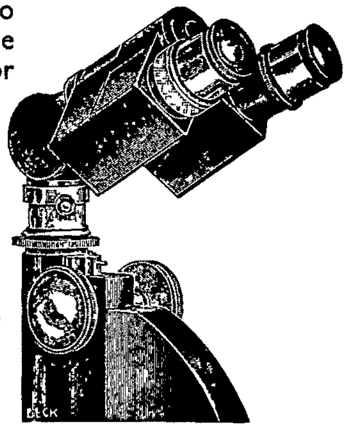
BECK BINOCULAR
EYEPIECE ATTACHMENT

Angular Model

This attachment enables the monocular microscope to be instantly converted into the binocular type. It can be used with any power object glass and has all the qualities of the binocular bodies which are built into the microscope. The inclined angle is a great convenience for those who work with the microscope for prolonged periods.

Catalogue giving full details forwarded on application.

R. & J. BECK, Ltd.
69 Mortimer St.,
LONDON, W.1

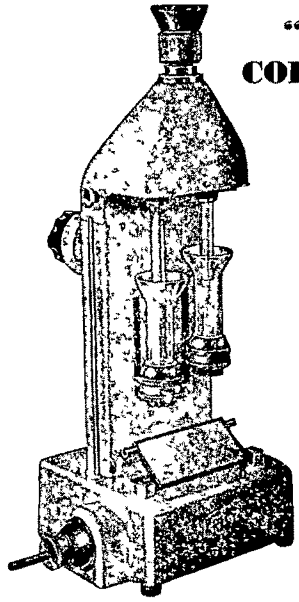


HAWKSLEY

"CRISTA"
COLORIMETER

With
macro- and
micro-cups
and
plungers

Particulars
on
request



HAWKSLEY & SONS Ltd.
17 NEW CAVENDISH ST., LONDON, W.1
Telephone WELbeck 3859 Telegrams "Diffract, Wesdo, London"

GREEN'S PURE
FILTER PAPERS

Write for samples
and free Booklet on Filtration
called "Signposts"

◆

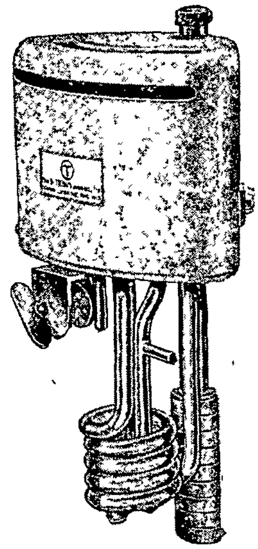
J. BARCHAM GREEN LTD.
• Maidstone • England

THE TECHNE TEMPUNIT

This self contained constant temperature control unit has been widely sold and in its new form has features that place it in a class by itself. The unique pneumatic control system has all the sensitivity of electrical contact methods with far greater dependability and longevity.

Control is ± 0·5°C.

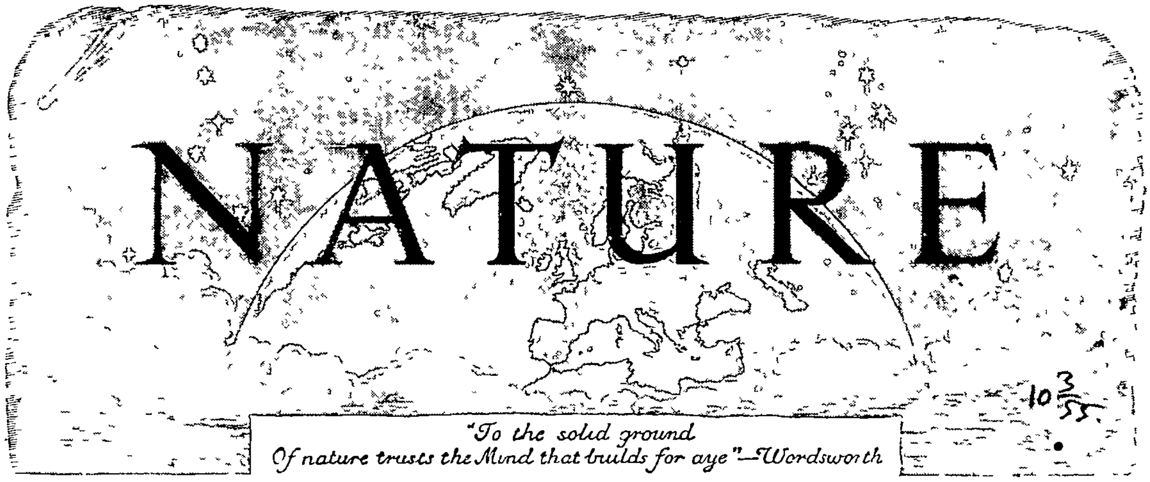
Range from room temperature to 96°C.



For full details
write to:

TECHNE (CAMBRIDGE) LTD DUXFORD CAMBRIDGE ENGLAND

Printed in Great Britain by Fisher, Knight & Co., Ltd., The Gainsborough Press, St. Albans, and published by Macmillan & Co., Limited, at St. Martin's Street, London, W.C.2, and St. Martin's Press, Inc., 103 Park Avenue, New York 17, N.Y., U.S.A.—Saturday, January 29, 1955



NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye"—Wordsworth

10 3 55

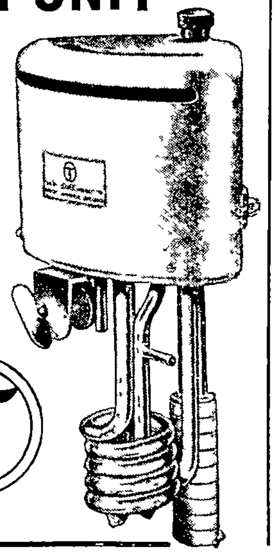
Vol 175, No 4449 SATURDAY, FEBRUARY 5, 1955 Two Shillings

TECHNE TEMPUNIT

This self contained constant temperature control unit has been widely sold and in its new form has features that place it in a class by itself The unique pneumatic control system has all the sensitivity of electrical contact methods with far greater dependability and longevity

Control is ± 05°C
Range from room temperature to 96°C

TECHNE (CAMBRIDGE) LTD
DUXFORD CAMBRIDGE ENGLAND



Optical Fused Quartz

Transparent fused quartz can be supplied for optical purposes as blanks for plates, lenses, prisms, etc , or as finished optical elements up to the highest degree of optical finish and freedom from strain

It is manufactured in various grades, thus providing a suitable quality for each class of work ranging from the most exacting uses in ultra-violet optical determinations to ordinary work in the near ultra-violet and infra-red regions We shall be pleased to recommend a suitable quality for your particular application

THE THERMAL SYNDICATE LTD.
WALLSEND, NORTHUMBERLAND
London Office, 12–14, Old Pye St , Westminster, S W 1

MSE 'MAGNUM' CENTRIFUGE

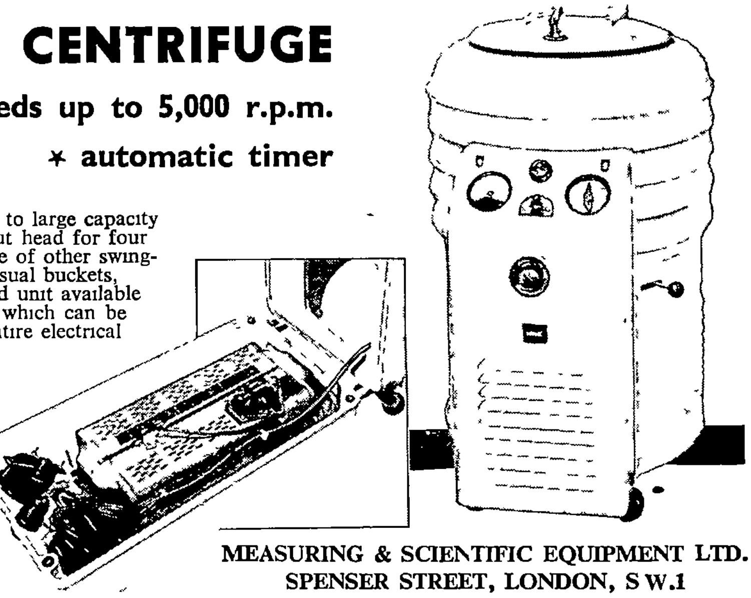
- capacity 2·4 litres
- speeds up to 5,000 r.p.m.
- large range of accessories
- automatic timer

This is the perfect general-purpose medium to large capacity centrifuge It will accommodate a swing-out head for four 500-ml or 600-ml bottles and a large range of other swing-out, angle and basket-type heads with all usual buckets, adaptors and multiple carriers Super-speed unit available All controls are grouped in a single panel which can be hinged right down for easy access to the entire electrical installation

MSE

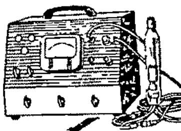
Full details in MSE Publication 133 on request

MEASURING & SCIENTIFIC EQUIPMENT LTD.
SPENSER STREET, LONDON, S W.1



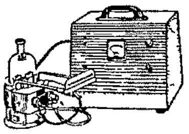
An EVER-INCREASING variety of Laboratories and Factories are depending upon –

THERMIONIC IONISATION
Range 10^{-8} to 10^{-3} mm Hg
Electronic gauge for the highest vacuum measurements

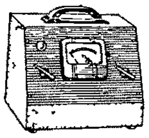


–the world's most comprehensive range of VACUUM GAUGES

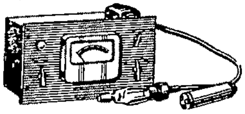
INDUSTRIAL KNUDSEN
Range 10^{-7} to 10^{-4} mm Hg
Developed to a surprising degree of ruggedness. Measures TRUE gas and vapour *continuously*

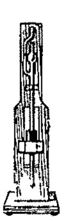


COLD CATHODE IONISATION
Range 10^{-5} to 10^{-3} mm Hg
A less expensive alternative to the more elaborate thermionic gauge



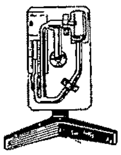
THERMAL-CONDUCTIVITY TYPE
Range 10·0 to 0·0001 mm Hg
The most generally useful gauge. Models available for continuous indication, multi-point recording and battery operation





McLEOD
Ranges 10·0 to 0·00001 mm Hg
Models available, industrial enclosed, rubberless and bench types

MINIATURE McLEOD 'VACUSTAT'



Ranges 10·0 to 0·01 and 1·0 to 0·001 mm Hg
A swivel-operated gauge in forms suitable for Bench, panel mounting and all-glass systems

CAPSULE DIAL GAUGE
Ranges 0–20 to 0–760 mm Hg

Barometrically compensated

W. EDWARDS & CO (LONDON) LTD
for better vacuum service
MANOR ROYAL · CRAWLEY SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY
BRANCHES GLASGOW & TORONTO *AGENTS THROUGHOUT THE WORLD*

ACCURATE MICRO-CURRENT RECORDING

THE UNIQUE *Fielden* WAY

"Servograph" Electronic Single and Multi-point Recorders, Indicators, and Recorder-Controllers all incorporate the unique Fielden working principle and are increasingly accepted as the alternative to complex and expensive potentiometric equipment

ACCURACY

The "Servograph" can be installed as a direct substitute for any moving-coil indicating meter and will reproduce meter accuracy. It remains unaffected by mains fluctuation

ROBUST PEN UNIT

Ample writing power is obtained from the servo loop, thus eliminating pen friction troubles and making delicate balancing and levelling unnecessary, whilst ensuring faithful reproduction of the smallest increments

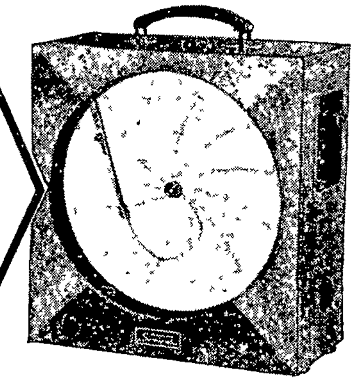
RANGES

Standard Models are available in three ranges of 50 micro-amps, 1 milli-amp and 30 milli-volts full scale.

Full-scale deflection time with the 1mA model is 1·5 seconds without overshoot

ECONOMIC COST

The ingenious design and execution of the "Servograph" range of instruments permits of their being marketed at a remarkably low figure having regard to their performance. Service and maintenance prove to be negligible



Fielden INSTRUMENTATION

Write for publication No 200/FE/44 giving full details to
FIELDEN ELECTRONICS LTD • WYTHENSHAWE • MANCHESTER
Telephone. WYThenshawe 3251 (4 lines). Telegrams. HUMIDITY, MANCHESTER
London Office : 21 Buckingham St., W.C.2. Telephone : TRAfalgar 3154

CASELLA LONDON

WHIRLING HYGROMETERS

for the accurate estimation of relative humidity

TWO MODELS AVAILABLE

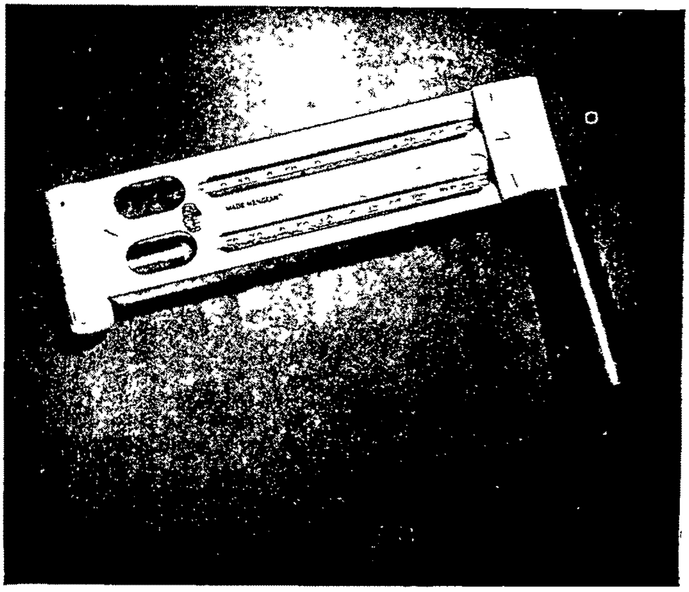
An ordinary pattern with plastic handle, water bottle and fittings £2 15 0

An illuminated model for increased accuracy of reading in poor illumination £4 16 3

Both models from stock—please write for further details

C. F. CASELLA & Co. Ltd.
REGENT HOUSE
FITZROY SQUARE
LONDON, W.1
Telephone ★EUSton 3944

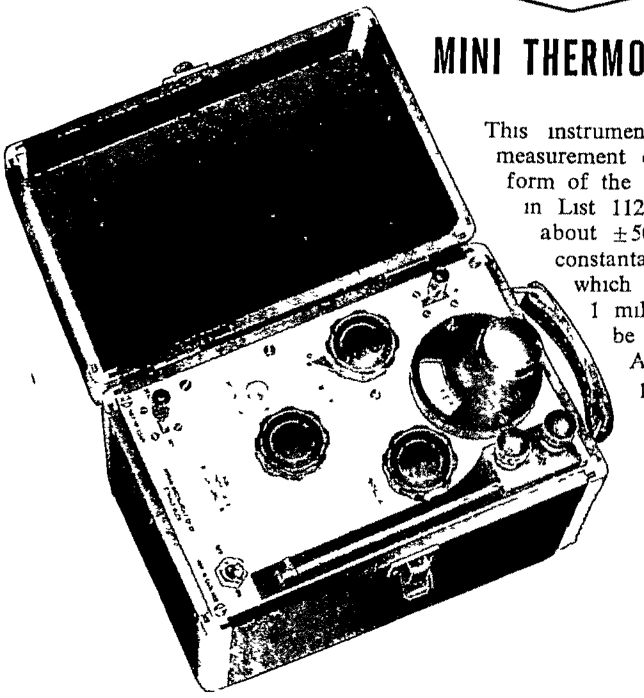
Member Scientific Instrument Manufacturers' Association of Gt Britain



DORAN

MINI THERMO-COUPLE POTENTIOMETER

CATALOGUE NO. E.4221



This instrument was developed in connection with the measurement of temperature in grain, and is a modified form of the Mini Thermo-couple Potentiometer described in List 112 It enables temperature differences up to about ±50° C to be measured using a single copper constantan thermo-couple junction The slide wire which is divided into 100 divisions has a range of 1 millivolt and a single step of 1 millivolt can be added at will by means of a simple switch A metal block and a mercury thermometer provide a suitable reference junction, and a reversing switch permits measurements of temperature above and below the reference junction temperature to be made without touching the connecting leads The instrument is completely self-contained with galvanometer, standard cell and dry battery

SPECIFICATION:

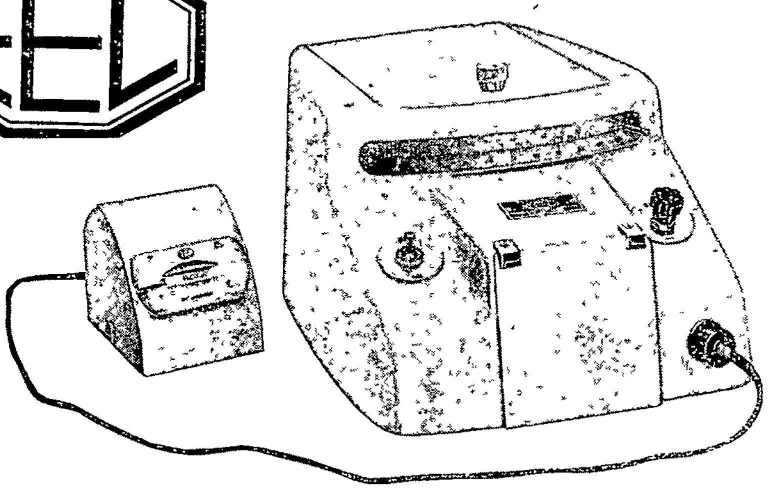
Range	2 millivolts
Weight	8 lb
Dimensions	8¾" × 5¾" × 5¾"

Tel Stroud 462

DORAN INSTRUMENT CO., LTD.
STROUD, GLOS.

London Office
Tel ADD 2369

THE EEL



REFLECTANCE SPECTROPHOTOMETER

This instrument is designed to provide, accurately and rapidly, means of assessing the colour composition of a sample It may be used for measurements on paper, plastics, paints, dyes, inks, etc , and, in fact, on any flat surface. It also enables one to obtain direct readings closely approximating to the X, Y and Z coefficients of the C.I E system.

★ **NINE FILTERS** conveniently mounted in a wheel provide a ready means of measuring the percentage reflectance throughout the spectrum from readings on the 15 cms long galvanometer scale.

★ **GRAPH BOOKS** are available in which these values may be plotted directly on prepared ordinates, giving the spectral distribution curve for the sample relative to the standard

★ **MAGNESIUM CARBONATE** blocks, mounted in holders, are supplied to serve as standard white reference surfaces

★ **TRISTIMULUS READINGS** may be made directly with a special filter wheel which is easily interchangeable with the "Spectrum" wheel

★ **STANDARD CONDITIONS** of 45° illumination and normal viewing of the sample are adopted to avoid errors due to gloss

★ **DOUBLE SENSITIVITY** is provided for accurate measurement of low reflectance values by the removal of a neutral filter from the light beam by means of a hand-operated lever.

★ **VOLTAGE STABILISATION** is provided to correct mains voltage variations of ± 20%.

Full details of this and other instruments will be sent with pleasure

SELENIUM PHOTOCELLS
NEPHELOMETERS
PHOTOMETERS
DENSITOMETERS
FLAME PHOTOMETERS

EVANS ELECTROSELENIUM LTD

Sales Division 25 HARLOW ESSEX

ELECTROPHORESIS APPARATUS
OPACIMETERS
COLORIMETERS
DAYLIGHT FACTOR METERS
REFLECTOMETERS
ABSORPTIOMETERS
etc , etc

Representatives for sales and service

Manchester area —Messrs A. M Lock & Co , Ltd , Crompton Street, Chadderton, Oldham, Lancs
North of England —Messrs Electricals, Ltd , 14 Claremont Place, Newcastle-upon-Tyne, 2
Scotland —Messrs Atkins Robertson & Whiteford, Ltd , 92-100 Torrisdale Street, Glasgow, S 2.

BTL

INSTRUMENTS IN ACTION

B.T.L. VAN SLYKE MANOMETRIC GAS ANALYSIS APPARATUS

The photograph on the left is of the apparatus in use at the Chester Beatty Research Institute, Royal Marsden Hospital, for blood gas analysis This instrument is now also in demand outside the biochemical field, where the quantities of determinate are very small Applications of the Van Slyke manometric methods are recommended, for example, in the determination of Amino Nitrogen and Carbon in organic material and the estimation of Carbon Monoxide in air and Carbon Dioxide in aqueous solutions

The Van Slyke Standard Manometric gas analysis apparatus has been completely redesigned to conform to modern practice and the following features are of particular interest

- Glass water jacket is illuminated to give a clear view of the shaking pipette
- Manometer fitted with illuminated meniscus reader for accurate readings
- Easy adjustment of manometer and connecting tubes
- Totally enclosed motor and drive mechanism.
- Rotary rheostat for control of shaking speed from a maximum of 200 per minute
- Timer and alarm buzzer can be fitted as an extra

Price £63 or with timer £73 10s Immediate Delivery Full details will be sent on request

BTL

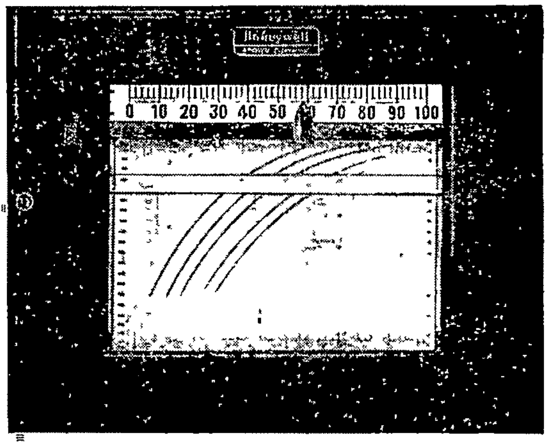
SCIEX

BAIRD & TATLOCK
(LONDON) LTD.
Scientific Instrument Makers
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

ELECTRONIK

FUNCTION PLOTTER

records y = f(x)



The Function Plotter—curves show relationship between two variables, one as a function of the other

The Honeywell-Brown Function Plotter automatically plots curves showing the continuous relationship of two variables

- **Speed versus Torque**
- **Stress versus Strain**
- **Temperature versus Pressure**
- **Amplifier Output versus In-put**
- **Antennæ Radiation Patterns**
- **Plate Current versus Grid Voltage**
- **Plate Voltage versus Plate Current (and other Electron Tube characteristics)**

The following records are among many which can now be obtained with speed, accuracy, and efficiency

- **Temperature versus Temperature Difference**
- **Hysteresis Loops**
- **Engine Speed versus Governor Position**
- **Pressure versus Displacement**
- **Volume versus Pressure**
- **Force versus Motion**
- **Force versus Displacement**

The Function Plotter is essentially a Single Pen Strip Chart Recorder equipped with two measuring systems The chart is driven up and down in response to changes in one variable and the pen moves simultaneously in response to changes in the second variable A full scale travel of 11 inches is available on both axes Pen and chart mechanisms can be energised by any D C source The Honeywell-Brown Function Plotter is fully described on Instrumentation Data Sheet No 10 0 -5b Requests for this interesting and important 4-page leaflet should be addressed to Honeywell-Brown Ltd, 1 Wadsworth Road, Perivale, Greenford, Middlesex.

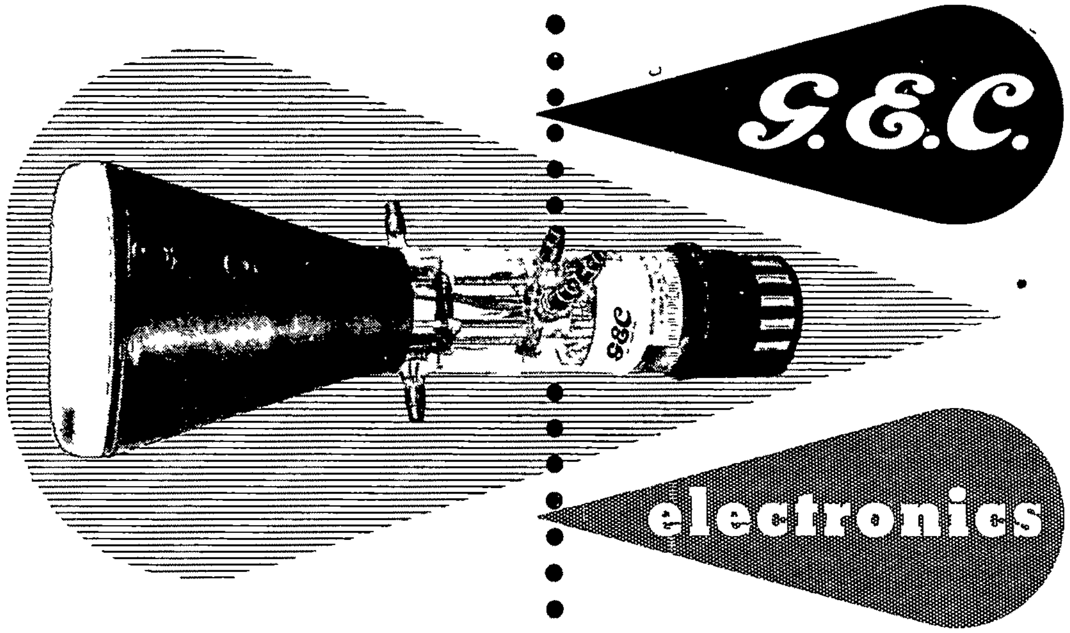
Sales Offices located in the principal cities of Britain and throughout Europe

H HONEYWELL

Honeywell

BROWN INSTRUMENTS

First in Controls



Special purpose Cathode Ray Tubes
for Research and Industry

A range of cathode ray tubes is available for use in specialised applications such as the observation and recording of high speed transient phenomena, where the high capacitances and other limitations of the usual type of instrument tube would result in distortion or complete suppression of the trace

Typical applications of these special tubes include high voltage cable testing insulator overload and breakdown testing, cable fault finding by quasi-radar technique and the investigation of high voltage switching phenomena

They are also suitable for use in laboratory oscilloscopes

Brief details of some of the more popular types are given below The tubes are of the all-electrostatic type, with heater ratings of 4V, 1 0A (approx)

401 CAHA
408 CAHA
Rating
Va3 (max) 1 5kV
Vp d a 3 3 5kV
Sx (av) 0 090mm/V
Sy (av) 0 100mm/V
Screen 401 CAHA Green-visual
408 CAHA Killed blue—photographic
Base B9G (pressed glass)

4cm dia high vacuum monitor tubes with one stage of post deflection acceleration For use in laboratory oscilloscopes, multi-channel strain-gauge recording equipment, etc.

908 BCC
Rating
Va3 (max) 10kV
Sx (av) 400/Va3 mm/V
Sy (av) 750/Va3 mm/V
Screen Killed blue—photographic
Base B12D

A 9cm dia flat screen high speed recording tube with a low capacitance deflecting system The connections to the plates and final anode are brought out through side-arms Writing speeds of the order of 30,000 km/sec are possible, and transients of the order of 10^{-9} sec may be recorded

908 CARA
Va3 4kV
Vp d a 8kV
Sx (av) 0 085 mm/V
Sy (av) 0 12 mm/V
Screen. Killed blue—photographic
Base B12D

A 9 cm dia flat screen high speed recording tube with one stage of post deflection acceleration For use where the special features of the 908 BCC cannot be employed to full advantage The Y plate connections and final anode are brought out through side arms

1601 ABC
Va3 (max) 5kV
Sx 660/Va3 mm/V
Sy 1100/Va3 mm/V
Screen Green—visual
Base B12D

A 16cm dia flat screen high speed oscillograph tube The construction is of the low capacitance type with the deflector plates and final anode connections brought out through side arms

1608 BCCA
Va3 (max) 3 5kV
Vp d a 3 (max) 10kV
Sx (av) 0 15mm/V
Sy (av) 0 27mm/V
Screen Killed blue—photographic
Base B12D

A 16cm dia flat screen tube of similar low capacitance construction as the 908 BCC, but with three stages of post deflection acceleration This tube will achieve similar writing speeds and recording periods as the 908 BCC, and is recommended for use where the deflecting potentials available are limited

Alternative screens are available including long after-glow and white and blue aluminised types

Other types of special tubes are available including
Double gun tubes Storage tubes.
Television monitor tubes
Conical deflection systems tubes for radial time bases Monoscopes, etc

Write to Osram Valve and Electronics Dept for full technical details
THE GENERAL ELECTRIC COMPANY LTD , MAGNET HOUSE, KINGSWAY, LONDON, W C 2

Balance users....

OERTLING

Releas-o-matic Balances

Speed with Accuracy

Releas-o-matic

L. Oertling Ltd. CRAY VALLEY ROAD ST MARY CRAY, ORPINGTON KENT

. . you will be interested in this leaflet about the now considerably extended range of *Oertling* **Releas-o-matic Balances.**

They are designed for rapid use — up to 60 weighings per hour are possible—without any fear of damage or early loss of accuracy

Each incorporates the unique Releas-o-matic device which, briefly, removes 85% of knife-edge wear by controlling, **independently of the user,** the velocity of impact of knife-edge on plane at release.

By making rapid weighing safe, the new models help solve the big problem of how to get more weighings in limited space

OERTLING

PIONEERS IN BALANCE DESIGN
FOR OVER 100 YEARS

Please send me a free copy of "Oertling Releas-o-matic Balances."

L. Oertling Ltd., Cray Valley Road, St Mary Cray, Orpington, Kent. Telephone Orpington 25771 (5 lines)

Name

Address

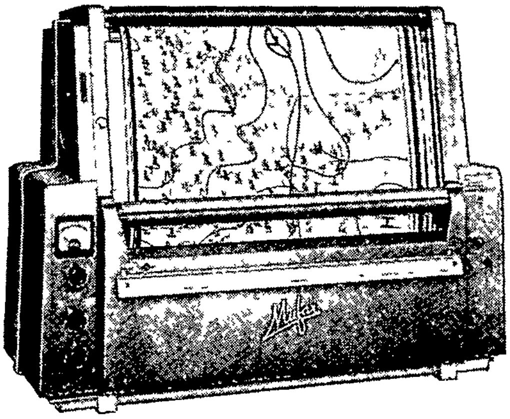
(N)

TAS/OR 372

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

MAKERS OF HIGH GRADE PRECISION ELECTRICAL INSTRUMENTS

MUIRHEAD PICTURE TELEGRAPH EQUIPMENT

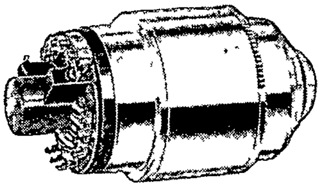


D-649 18″ MUFAX CHART RECORDER

MUIRHEAD

A comprehensive range of phototelegraphic transmitters and receivers for line and radio working. Mufax chart recorders and picture receivers, employing a method of continuous non-photographic recording on inexpensive Mufax electro-sensitive paper

MUIRHEAD MAGSLIPS

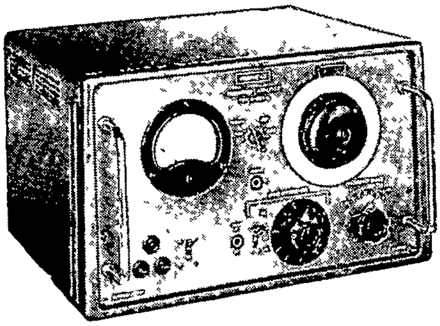


E-24-C MAGSLIP RESOLVER

MUIRHEAD

Magslip elements of various sizes for remote indication and control, for computation and summation, and for use in servo systems Motors and amplifiers for servo purposes and other small-power applications

MUIRHEAD INSTRUMENTS



D-669 FREQUENCY ANALYSER

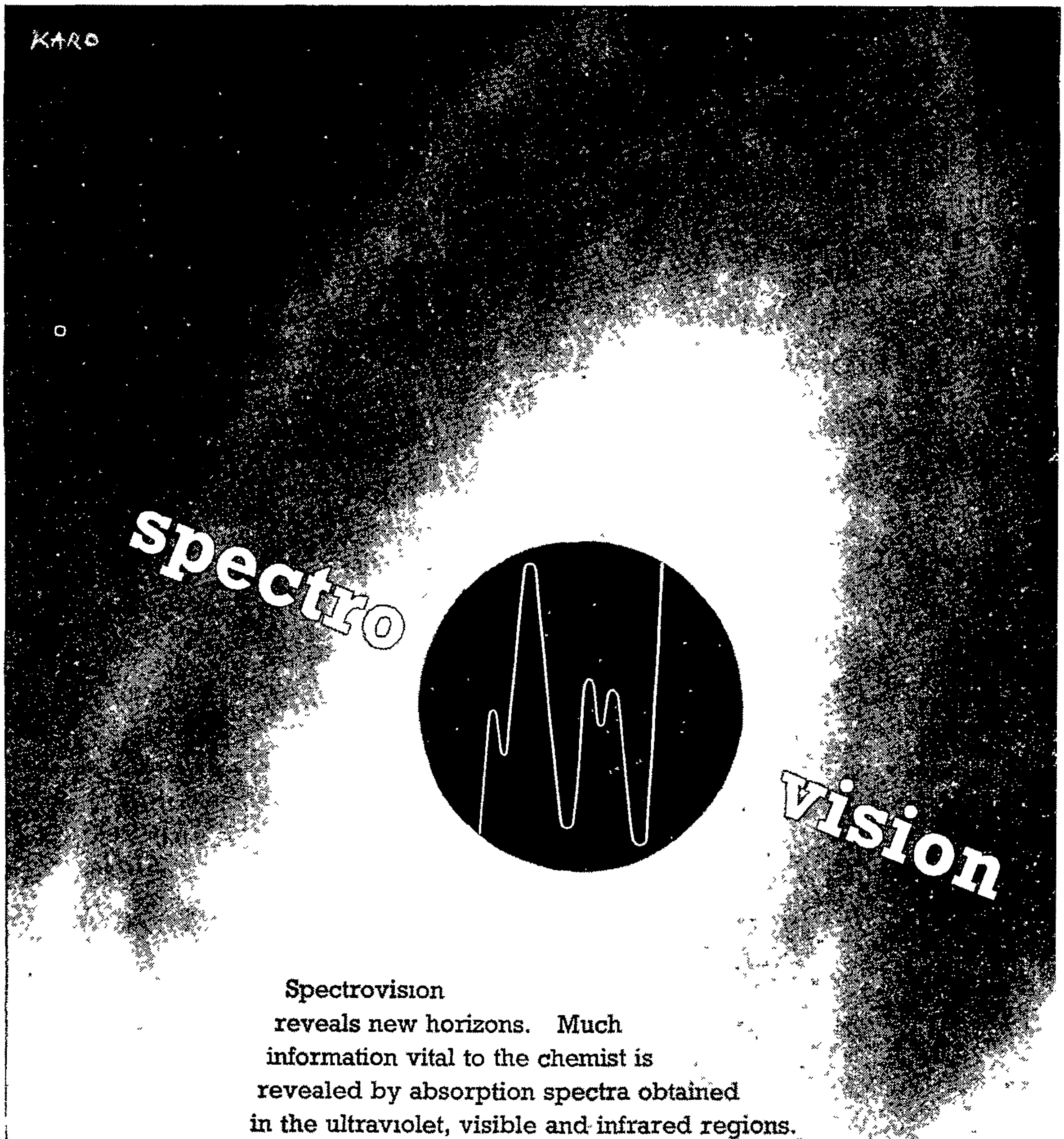
MUIRHEAD

Resistance - capacitance — tuned audio - frequency oscillators, decade and continuously variable, for frequencies from 0.1c/s to 100kc/s. Valve-maintained tuning forks, phonic motors and observatory timing devices Instruments for waveform analysis and vibration measurement

OTHER MUIRHEAD PRODUCTS INCLUDE:—

Decade resistance boxes · Wire-wound resistors · Attenuators · Variable Air Capacitors
AC bridges · DC laboratory equipment · Key and stud switches · Instrument dials and drives
Audio-frequency transformers

Write under your business letterhead for our catalogue



Spectrovision reveals new horizons. Much information vital to the chemist is revealed by absorption spectra obtained in the ultraviolet, visible and infrared regions. The tool for this purpose is the spectrophotometer which provides analytical data easily and accurately, speeding research and production and preventing waste. Unicam Instruments of Cambridge will gladly tell you how you may add the faculty of Spectrovision to your present resources.

UNICAM
SPECTROPHOTOMETERS

NATURE

No 4449 SATURDAY, FEBRUARY 5, 1955 Vol 175

CONTENTS

Page
Control of Technological and Technical Education in Britain 223

Literature and Science By Dr H Hamshaw Thomas, M B E, F R S 226
Geomorphology from an American Point of View By Prof Gordon Manley 226
Synthetic Polymers By Dr F Happey 227
Kernel Functions By Prof H T H Piaggio 228
Chemical Engineering By Prof F H Garner, O B E 228

Recent Infra-red and X-Ray Studies of Coal By J K Brown and P. B Hirsch 229
British–Kenya Miocene Expeditions Interim Report By Dr L S B Leakey and Sir Wilfrid Le Gros Clark, F R S 234
The Photographic Process By Prof N F Mott, F R.S. 234

Obituaries

Prof A R Richardson, D S O, F R S By Prof R Wilson 235
Prof Douglas McCandlish By Prof Donald Burton 236

News and Views 237

The National Food Survey in Great Britain 241
Geophysical Aspects of Solar Flares By Prof V C. A Ferraro 242
Field-Emission and Surface Phenomena · Symposium at Pittsburg By Prof. F Llewellyn Jones 244
Chromatography. By Prof D. C Harrison 245
The Expanding Universe 246
Recent Mollusca of Canada 246
Influence of Monolayers on the Natural Rate of Evaporation of Water By W W Mansfield 247
Synthesis of Carbohydrates from Carbon Dioxide and Hydrogen in a Cell-free System By Dr E Racker 249

Letters to the Editors

Use of the Nitric Oxide/Oxygen Continuum in the Estimation of the Relative Concentrations of Oxygen Atoms in Flame Gases.—Dr C G James and Dr T M Sugden 252
Comparison of the Spectra produced by Shock Waves, Flames and Detonations—A R Fairbairn and Dr. A G Gaydon, F R S 253
Laboratory Production of the Vegard–Kaplan Bands—Dr N D Sayers, G R Taylor and Prof K G Emeléus 254
Measurement of the Doppler Width of the λ5577 Line in the Night Sky—David Q Wark and John M Stone 254
Melting Points of Mono-*N*-*n*-alkylaniline Hydrochlorides—R Foster and Dr D Ll Hammick, F R S 255
Chemical Composition of the Melanin Granule and its Relation to the Mitochondrion—W D Stein 256
Production of Cancer of the Bile Ducts with Thioacetamide—D N Gupta 257
Urinary Excretion of a Substance after a Single Dose.—Babette E Stern 258
Action of Ribonuclease on Certain Ascites Tumours—L Ledoux 258
Deoxyribose Nucleic Acid Values in Tumour Cells with Reference to the Stem-cell Theory of Tumour Growth—B M Richards 259
Identification of Hypocalcified and Demineralized Areas in Sections of Human Enamel—J J Hodson 261
Do Tracers measure Fluxes ?—C Edwards and Dr E J Harris 262
Incidence of Hæmoglobin C in the 'Coloured' Population of Cape Town—Dr Peter Brain ; Dr H Lehmann 262
Endoparasitism in Trombiculid Mites—Dr J R Audy and P H Vercammen-Grandjean 263
Polychaeta New to the British Isles—Eve C Southward. 264
Role of Pectic Enzymes in the *Verticillium* Wilt Disease of Cotton—M Kamal and Dr R K S Wood 264
Physiological Disease of Rice attributable to Iron Toxicity—F N Ponnamperuma, R. Bradfield and M Peech 265
The Gregarious Setting Reaction of Barnacles as a Measure of Systematic Affinity—Dr E W Knight-Jones 266
Independence in Publication—Prof A V Hill, C H, F R.S 266

DIFCO

DETECTION OF THE GONOCOCCUS

The superiority of the cultural method over the usual microscopic technique for detection of gonococcal infections has repeatedly been demonstrated. The cultural method is especially indicated in chronic and treated cases and for determining the release of patients. The use of the following standardized materials has simplified the diagnosis of gonorrhoea by the cultural method.

Bacto-G C Medium Base
Bacto-Proteose No. 3 Agar
Bacto-Dextrose Starch Agar
Bacto-Phenol Red Media
Bacto-Supplement A
Bacto-Supplement B
Bacto-Hemoglobin
Proteose Peptone No. 3

Specify "DIFCO"
THE TRADE NAME OF THE PIONEERS
In the Research and Development of Bacto-Peptone and Dehydrated Culture Media

Sole Agents for Gt. Britain

BAIRD & TATLOCK (LONDON) LTD.
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

D

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

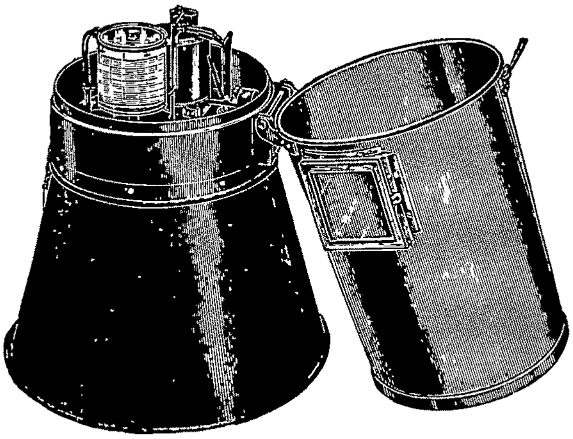
BUYING?
Suppliers to all Leading Universities, Public Libraries and Institutions of the World. Catalogues issued ★

SELLING?
★ Specialists in Scientific, Technical Books and Publications of all Learned Societies

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephone. Wel. 7948, Amb. 5991

THE DINES
TILTING SYPHON
RAIN GAUGE



Overall Height - - 34 in
Diameter of base - 20 in

This is the very latest type of Self-recording Rain Gauge, fitted with a tilting arrangement which ensures a complete syphoning when the rain water has filled the float chamber.

Price and further particulars on application from the Makers

HEATH, HICKS & PERKEN (Thermometers) LTD.
(associated with W F Stanley & Co, Ltd)
NEW ELTHAM, LONDON, S.E.9
Phone ELTHAM 3836 Grams "Optimus, Souphone" London

CONTROL OF TECHNOLOGICAL AND TECHNICAL EDUCATION IN BRITAIN

IN the debate in the House of Lords on December 7 on higher technological education, Lord Salisbury repeated the statement on Government policy already made in the House of Commons earlier that day. The debate arose out of a motion of Lord Glyn in regard to the somewhat disappointing memorandum on that subject drawn up by a sub-committee of the Parliamentary and Scientific Committee, of which Lord Glyn was chairman. Lord Salisbury accepted the main argument of the Committee as to the seriousness and urgency of the situation, and the importance of dealing with the shortage of science teachers and creating a satisfactory climate of opinion in Great Britain in relation to science and technology in order to secure an adequate number of scientists and technologists. Lord Salisbury dismissed, however, as unnecessary the suggestion that any further inquiry should be made into the number of technologists required to meet the needs of various departments of the national life of Britain. He accepted it as sufficient that we are nowhere near saturation point at present, and in this view he had the support of most other speakers, including Lord Baillieu, Lord Glyn, Lord Falmouth, Lord Waverley and Lord Cherwell.

Lord Salisbury, in referring to school leavers, corrected one statement in the memorandum under discussion. Of the 8,000 State scholars, he pointed out, some 5,000, and not 600, are studying science, and many of these would no doubt become technologists. But while he recognized that steps should be taken to see that a good proportion of the best brains are attracted to science, he deprecated the Parliamentary and Scientific Committee's reference to the abandonment of "the arbitrary dictum of the Barlow Committee that the numbers of arts students at the universities should be doubled as well as the numbers of science students". There was no such dictum, Lord Salisbury said, nor did he think that it was helpful to consider this question of balance on a basis of percentages. It might indeed be observed that, in much of the discussion of technological education and of science and the humanities which has marked the educational conferences of the New Year, there has been indifference to first principles. Mark Pattison's discussion of the functions of higher education and of the university, of the importance and value of close interaction between university and society, of the proper subject of university studies, of liberal education and mental breadth has a strangely modern ring. The argument by which he supports his view that the products of a university are not inventions, improvements, discoveries, novel speculations or even books, but the fully educated man, goes closer to the root of the matter than many modern controversialists. The first part at least of his "Oxford Studies" is worth reading to-day for the light it throws on the conditions under which alone higher education in a university can be efficient.

Lord Salisbury, after a tribute to what the University Grants Committee had already done to increase the number of university students of science and technology since the War, stated specifically that, as already implied in Mr. Boyd-Carpenter's statement a year ago, the Government does not intend to pursue the idea of a new technological university but to build up and develop a number of existing institutions where science and technology already flourish and sometimes predominate. Moreover, Lord Salisbury laid some stress on the value of the closer connexion between science and technology which might result from the expansion of technological education in association with that of the universities. The statement which was read in both Houses of Parliament, for example, suggested that students of a particular technology should work closely with students of fundamental science and of its application in other fields. Lord Salisbury himself seemed to favour the close association of higher technological education with other university studies, partly at least as a means of increasing the prestige and status of technology. The complaint was again voiced in the debate that technology, and even science, do not yet receive the prestige and status in comparison with the arts that they should, either on their intrinsic merits or from the point of view of the national interest, to ensure that a sufficient proportion of the nation's ablest intelligence is to be induced to follow careers in science and technology. Some encouragement may well be desirable and even necessary, and particularly efforts such as the Federation of British Industries has been making of late to indicate more clearly and precisely to the schools the opportunities which a career in industry can offer to the graduate in science or technology and its intrinsic satisfactions as well as material rewards.

There is, however, a danger here that the claims of science as against the humanities may be pressed too hard. The function of the university is to produce educated men and women, capable of independent thinking, of sound judgment and wide vision, and the needs of the community will not be served if the conception of the university as a place of vocational training is too narrow, no matter what that vocation may be, whether in the arts, in science or in technology. In terms of modern life, the community is as ill-served by a Civil servant or administrator ignorant of science and unable to assess the significance of scientific or technical factors in a situation with which he is confronted, as it is by the technologist or scientist who is incapable of taking a balanced view and making allowance for the human values and other considerations which should influence the decision even on problems essentially scientific and technical.

This needs to be remembered, for it is the capacity for independent thought, for judgment and for vision that is important: the medium by which that capacity is developed is largely irrelevant. It can be developed as readily by a scientific and technological education as by one in the humanities; but it does not follow that it will be so developed. What matters is not so much the medium as the character of the training; and the prestige of the humanities in this respect is not so much due to their field as such—though they have certain inherent advantages—as to the way in which in certain schools they have been taught.

Lord Salisbury's remarks are not entirely free from danger in this respect, particularly if his statement that the Government has rejected the idea of a technological university should be misconstrued. The Government has declined to found and experiment with an entirely new institution; but when the programme it has announced for the expansion of the Imperial College of Science and Technology is complete, in size of teaching and research staff, in its range of buildings and equipment, the College will clearly be a technological institution of the first rank. Moreover, at the Imperial College real efforts have been made during recent years to encourage breadth of view and contacts between different faculties and studies, though there has been some argument as to whether the influence of humanities is anything like as strong as in the great technological institutions on the Continent and in the United States.

It would be unfortunate, however, if the argument as to whether or not students of technology in universities in Britain get a broader education than those studying in a foreign institute of technology distracted attention from the importance of giving fresh attention to the question not only of how best the sciences and the arts as well as technology can be used as mediums of education for understanding the world in which we live, but also of assisting intercourse and discussion between students of different disciplines and faculties. Unless attention is directed specifically to such questions, there is danger that the expansion of technological education within the universities—at the Imperial College of Science and Technology, at Glasgow, at Manchester and elsewhere—may lead to segregation rather than to the intercourse and the sharpening of minds. Probably here, as the Government statement indicates, the influence of industry could be beneficial. "The problems of industry are problems of human relations, as well as of science, and in training for industry the humanities have an important part to play". Comments made by industrialists at conferences on industry and the universities suggest that the influence of the universities in this respect may be as important as the financial support recently given in the Universities of Durham, Edinburgh, Nottingham and Wales to which the Government statement referred.

Lord Salisbury, however, indicated that the Government is also proposing to develop higher technological education to some extent in the colleges of technology as well as in the universities of Britain; but here he was not altogether precise in his distinction between technological and technical education. Referring to the proposal to develop ultimately some thirty major technical colleges into advanced regional colleges, he agreed that it is desirable to segregate the lower-grade work as soon as possible from the more advanced work, so as to leave the selected colleges with more freedom to provide advanced technology and to conduct applied research. He appeared, however, to accept without question the practicability of carrying out technical and technological education within the same institutions, and he dismissed as unjustified the claim for academic independence for the selected colleges of technology. Sir David Eccles's subsequent proposal that the Salford Royal Technical College should concentrate on advanced work for students more than eighteen years of age and cease to take students under that age suggests that the Minister of Education has at least misgivings on the former point.

The arguments of the Parliamentary and Scientific Committee in regard to the importance of such independence to enable the technical colleges to attract teaching staff of the requisite calibre and to provide the continuity and range of courses were not really examined by Lord Salisbury. He indicated that the Government has rejected the proposal of the Committee to establish a few such selected royal chartered colleges of technology; but, apart from the failure to discriminate, where the technical colleges are concerned, between technical and technological education, his statement, taken with that of Sir David Eccles on December 14, leaves a distinct impression that the Government's policy may spread available resources too thinly where technological education is concerned. That Great Britain can afford the resources to develop more than half a dozen institutions on a scale which will ensure a broad enough training in really well-equipped institutions may be doubted, no matter how generous the co-operation and support of local industry. Indeed, it is to be questioned whether the necessary teaching and research staff for half a dozen institutions could be assembled for several years, let alone for the twenty-four technical colleges in which courses in advanced technology have already been approved for an increased grant. On the other hand, despite Lord Salisbury's admission that five or six technicians and many first-rate craftsmen are required for every technologist, the Government statement will not dispel misgivings that nothing like enough effort is being given to the training of technicians and craftsmen, even to remove the shortcomings disclosed.

The Government statement puts recurrent expenditure on technology at the universities as about £3 million a year, with an increase of some 25 per cent in the next two years, and capital expenditure already incurred of £10 million, and probably a further £15 million over the next ten years. These sums are quite substantial enough to warrant the establishment of a technological grants committee, parallel with the University Grants Committee and similar in status and organization. That suggestion of the Parliamentary and Scientific Committee's memorandum was strongly supported in the debate, not only by Lord Glyn but notably by Lord Waverley and Lord Cherwell. Lord Waverley thought that a body dealing with higher technical education in parallel with the University Grants Committee would serve an extremely useful purpose in advising the Lord President of the Council in a matter which he, and even more emphatically Lord Cherwell, considers quite outside the scope of the University Grants Committee as at present constituted

This proposal, as presented in the debate on December 7, would appear to contemplate such an oversight of technical as well as technological education as would keep the two in balance and assist in gaining for the technical colleges the conditions of service and esteem which they require, no less than finance and equipment, to enable them to do effective work. The mere existence of such a body could do something to increase the esteem in which the technologist and the technician is held, and thereby to remove the friction which has sometimes developed over discussions as to the respective functions of the colleges of technology and the technical colleges Prestige and status are important for other reasons than in assisting the colleges to attract staff of high qualifications and in inducing a sufficient number of the ablest school leavers to take up technological and technical careers It will be of vital importance that the functions and work of the technical colleges should be fully understood and esteemed by the community if there is to be any division of function such as Sir David Eccles seems to have in mind. The work of the technical colleges might well be seriously injured if it were thought that the task of training technicians and craftsmen were less important than, or inferior in status to, the task of training technologists

The proposal for a technological grants committee, if implemented with wisdom, vision and generosity, offers a prospect of enabling this question of the balance between technological and technical education to be handled in terms of the national interest and needs, and of eliminating the distortions which local and sectional interests and prejudices so readily engender It is not easy to over-stress the importance of such an impartial approach, and of avoiding party political prejudice As Lord Rochdale said, the problem of technological education has to be tackled with energy and force over many years, irrespective of the transient condition of trade and whatever political party may be in power at any particular time The Parliamentary and Scientific Committee could render no greater service than by continuing to demonstrate the practicability and value of an all-party approach.

Lord Salisbury, in his concluding remarks, stressed the desirability both of increasing the prestige and esteem in which technology is held compared with that of science, and of breaking down barriers between the arts and science Whether or not the importance which he rightly attaches to this process —and he recognizes it as one which may take generations to achieve—was responsible for his studied disregard of the Parliamentary and Scientific Committee's proposal for a technological grants committee, in spite of the powerful support it received, the proposal should be pressed It merits further examination and should be rejected only on a reasoned argument

The Government's statement of December 7 shows clearly that the Government is adopting a pragmatic and experimental approach and that it is proposing to spend substantial resources on the expansion of higher technological education in Britain. Lord Cherwell could remark with some justice that, even in regard to the Imperial College of Science and Technology, progress is somewhat slow, but it is sound policy not to attempt to stereotype the relations between technological institutions and the universities The arrangements in Manchester for the expansion of the College of Technology, with an independent governing body dealing direct with the University Grants Committee, which has been made possible by the City's surrender of its former ownership and control, and building new technical colleges for technical instruction at the lower levels, are eminently sensible, but not for that reason necessarily a pattern for general application

What the Government could fairly be expected to do is to bring some sense of urgency to bear where negotiations and discussions are protracted, and to create, as in a technological grants committee, a body competent to formulate broad policy in terms of the national needs and supply just that amount of balance required to ensure the adjustment of local differences in terms of the national and not sectional interest The argument for some such body is indeed strengthened by the failure of the Lord President to show himself aware of the way in which local views and prejudices hinder the higher work of the colleges of technology , or the vital importance of an autonomous governing body, to enable expenditure on technological courses or research or the admission of students on a regional basis to be independent of local rates and similar exigencies

Such considerations cannot be ignored in formulating long-term plans for the expansion of technological education in Britain, or in considering the efficient administration of the large sums of money which Lord Salisbury indicated the Government proposes to make available for the purpose Nor did anything that was said in this debate remove doubts which exist as to whether the Government has a considered and co-ordinated policy for the expansion of technological and technical education These doubts have indeed been increased since the debate. Not even Sir David Eccles's energy, or the cogency, soundness and clarity of his views on education generally, can remove the misgivings which divided responsibility for technical and for technological education tends to cause If the Government does not see fit to implement this proposal for a technological grants committee, it should at least make clear the means it proposes to adopt to remove the shortcomings in technical colleges disclosed by the Select Committee on Estimates for the Session

1952–53, and to prevent their recurrence, to overcome the well-known obstacles to the more efficient working of such colleges and colleges of technology at the higher levels, and to keep the expansion of facilities for training technologists and technicians in balance and in harmony with the country's needs Such questions cannot be dismissed summarily as they were by Lord Salisbury, and the Parliamentary and Scientific Committee would do well to inquire further into these and other points on which the debate threw insufficient light.

LITERATURE AND SCIENCE

Literature and Science

By B Ifor Evans. Pp 114 (London George Allen and Unwin, Ltd, 1954) 8*s*. 6*d* net

A BOOK on the relationship between literature and science should receive a warm welcome from both scientists and men of letters Often the scientist has no interest in poetry, which he neither understands nor appreciates, while the artist, being largely unaware of the nature and objects of science, may feel resentful of the way in which science seems to have come to dominate men's lives. Nevertheless, the full development of the intellectual life of our times depends on the work of both artists and scientists. Both should contribute to the philosophy which guides our thoughts and actions. On both sides there should be more realization of the aims and methods by which each works, the little book by Dr. Ifor Evans gives us some insight into the mind of the poet and artist.

The influence of scientific studies on men of letters is no new problem. The author reviews the way in which poets have reacted from the Renaissance onwards But in reading this historical survey, which occupies the greater part of the volume, considerable doubts must arise as to whether the past climates of thought on scientific matters have always been accurately depicted by the author. It may be easy for us to imagine which investigations should have impressed thoughtful Englishmen in the seventeenth and eighteenth centuries, because we know those which have stood the test of time. But it does not follow that the more lasting discoveries and theories had the greatest effect on contemporary opinion Thus in writing of the early years of the Royal Society, the author refers to the intermingling of myth and magic and superstition with scientific proceedings But the Fellows of the Society at that time had still to discover that some of the topics they discussed originated only in myth or mythology, for example, the idea that minerals grew in the earth from seeds was regarded as requiring serious investigation

Again, in an interesting chapter on Wordsworth, Dr Evans deals only with the poet's references to Newton and to mathematics But from about the time of the poet's birth until he was fifty, British scientists seem to have been mainly interested in biology and geology. Sir Joseph Banks was president of the Royal Society for more than forty years, and the physical sciences languished. This, too, was the period when many beautifully illustrated books on flowers and birds were produced and had a wide circulation The discussion of geological problems led to the founding of the Geological Society in 1807. It is not improbable that Wordsworth's first visit to the Alps was inspired by de Saussure's "Voyages dans les Alpes". The second part of this beautifully illustrated work by the pioneer of alpine exploration, geology and natural history, appeared some four years before the young enthusiasts set out to walk to Switzerland.

The author shows how, in the nineteenth century, scientists and men of letters drifted apart. He considers that "the main development within the twentieth century has been the increasing uneasiness of the writer, the sense that he exists in a hostile society, and that the powers of science are increasingly creating a civilization in which he has little place" It is, however, not easy to maintain the view that the pursuit of science destroys an appreciation of the arts Many distinguished scientists are accomplished musicians, painters or novelists The author recognizes the merit of Sir Charles Sherrington as a poet But those who devote all their energies to some subject, whether it be science, literature, history or golf, may well neglect other pursuits. It should be recognized that Charles Darwin, a sick man seldom able to leave his house and garden, was a special case Perhaps one reason why poets feel neglected to-day is that so much of what they write is not readily comprehensible to the ordinary reader, it is not of the kind which one reads and re-reads in leisure moments

In spite of the criticisms that have been made, this is an interesting book and contains much food for thought When one reflects on the mystery and complexity of the universe as revealed by modern science, and on the disappearance of the cocksure attitude adopted by so many of the nineteenth-century scientists, one would think that a *rapprochement* between scientists and poets should be possible We scientists should take note of the author's desire for "a wider act of interpretation, both of the nature of the scientific imagination and of the discoveries and possibilities of modern research"

H. HAMSHAW THOMAS

GEOMORPHOLOGY FROM AN AMERICAN POINT OF VIEW

Principles of Geomorphology

By William D. Thornbury Pp. ix+618 (New York John Wiley and Sons, Inc., London Chapman and Hall, Ltd, 1954) 64*s*. net.

GEOMORPHOLOGY as a science has grown up in the railway age A hint of what was coming might be espied in those eighteenth-century travellers who, like Gilpin, began very haltingly to display an interest in the form of landscape rather than its formalized versions. A hundred years later and the trains have reached Lucerne, soon we are well into the age of physiography, that pleasant ill-defined compost which made an agreeable part of the later Victorian education A further hundred years, and this lively branch of science has given birth to a remarkable variety of new and odd words such as pediplains, steptoes and fluviraption. Speed of communication, moreover, allows the students at a certain Scandinavian university to be flown out after the lecture to look at the land-forms from the air

Progress has been rapid, yet the discussion of the characteristics, origin and development of land-forms will long continue to provide an attractive and challenging mental discipline and a valuable education. Geomorphology not only gives scope for the exploratory and cartographical type of mind but also allows abundant opportunity to increase with time the precision of measurement, examination and analysis. Probing, indeed, may gradually replace mapping in this as in other fields.

The question remains, what initial training is most likely to lead to further advances. In America where, with the advantage of good visibility, the geologist must have an immediate eye for country and must often do his own mapping, it is understandably associated with departments of geology. In Great Britain, where the mapping has been done and the reward for geologists often lies deeper down, interest in surface-forms has been taken up by a number of geographers. The present reviewer is inclined to stand outside any such arguments. It is obvious that the geomorphologist in common with all who approach geophysical studies must have command of more than one auxiliary science; and as yet it matters little from which particular lecture-room he sets out, provided that he is endowed with the necessary capacity for vision. The earth's surface-form is an entrancing object of study approachable by many, and surely geographers should be allowed to study the changing environment if they wish and to leave man out of their inquiries.

Geomorphology owes much to the stimulus of the newer lands; and Dr. W. D. Thornbury has provided an admirable text-book. It is sound, solid, efficient, unpretentious, well illustrated; a workmanlike job forming an agreeable epitome of the splendid American achievement in this field. His training, outlook and location lead him to define the subject as primarily geology, and many will agree with his hope (p. 14) "that a knowledge of mathematics, physics and chemistry never becomes more essential to an understanding of geomorphic discussion than a sound appreciation of lithology, geologic structure, stratigraphy, diastrophic history, and climatic influence". His initial chapter on the historical background is a model of condensation; a steady succession of chapters is then laid down to cover processes, cycles, the peneplain concept, coastal evolution, vulcanism. To a non-specialist, the balanced summary of Davis *v.* Penck is particularly acceptable. The author allows geomorphology to extend to a discussion of the form of the ocean bed; but tectonics are neatly avoided. There is an admirable chapter on the tools of the geomorphologist such as contoured maps, aerial photographs, soil maps; and a final chapter on some applications which may encourage those who ask what money there is in it. For American students there is indeed little lacking. Some reference might perhaps have been made to recent Canadian arctic work, for example, by J. L. Jenness and J. B. Bird. Among minor points, while the references at the end of most of the chapters are adequately up to date, some later European work on glaciers might have been added. The author omits to define the snowline, which would assist the understanding of p. 357; the reader is given no obvious opportunity to follow up the brief mention of strandflats (p. 436), and on p. 259, obviously the east face of the Vosges is meant. The American usage of the word topography will be noted.

Illustrations and diagrams are plentiful and references abound, including quite a number to British and European work, though chiefly where it is likely to prove of interest to those engaged in the interpretation of North America. Students elsewhere will need to be well supplied with maps to make full use of the book. The author's reading does not appear to have spread far enough into British journals to mention the work of J. F. N. Green, O. T. Jones or D. L. Linton, although he is thoroughly acquainted with Wooldridge and Morgan (1937), and from beside the Indiana limestone a short comment is appropriately given to M. M. Sweeting (1950) on caves. Remembering W. M. Davis's early work, it is refreshing and may provoke thought for some English readers to find the Weald meagrely summarized in fourteen lines, no comments on the Thames and no mention of the Lake District. Landforms on the American continent, after all, provide much to think about; and to Dr. Thornbury, England's chief interest appears to lie in its coasts, to which he gives a generous allowance of illustrations and citations. Nevertheless, this book makes a deserving, crisp and stimulating text covering a wide field within the established canon. Geomorphology is a lively subject and Dr. Thornbury maintains a wholly admirable balance in his comments on matters of current controversy. His succinct summary of the theories of Appalachian drainage, of submarine canyons and of pediments may be selected as likely to prove very welcome to students. Production and printing are excellent; and while the appeal is primarily to American readers, and to British students the price is high, this book can be thoroughly recommended.

GORDON MANLEY

SYNTHETIC POLYMERS

Fibres from Synthetic Polymers

Edited by Dr. Rowland Hill. (Elsevier's Polymer Series on the Chemistry, Physics and Technology of High Polymeric and Allied Substances.) Pp. xv + 554. (Amsterdam and New York: Elsevier Publishing Company, Inc.; London: Cleaver-Hume Press, Ltd., 1953.) 80*s*.

THE editor and his panel of authors are to be congratulated on the general standard of this book. The rapid growth of knowledge on the subject of macromolecules owes much to the fundamental research of the chemist and physicist working on the synthesis and structure of long-chain molecules polymerized from one or more forms of monomer unit. Apart from reference to a few classical syntheses, for example polypeptides, few of the references are pre-war, and it is interesting to see this contemporary work built into a massive science. Further, this contribution may well be used as a sound lead to workers in the more complex fields of biosynthesis of the natural polymers.

If the work suffers from one major fault, it is that there appears to be some overlapping of subject-matter; but this may be inevitable as each author has to produce a coherent story. It can be seen that in particular p. 126 anticipates Chapter 14. On the other hand, chapters describing techniques frequently involve descriptions of chemical and physical properties of polymers which have been dealt with in the appropriate sections on their polymerization or properties. A reduction of this duplication might have been achieved by adequate cross-referencing. The value of the book as a work of reference is unimpaired; but the tenacity of the reader who has to follow 550 pages is greatly extended by the wide and ambitious scope of the work This is particularly noticeable as the involved treatment of the assessment of textile properties forms the last chapters of the book. It would be extremely difficult, if not impossible, to write these sections in the clear and concise manner of the earlier chapters, and I think that the parts of the book dealing with textile properties as such might better have formed the subject of another publication This criticism in no way detracts from the value of the chapters from the point of view of reference, and the treatment of the dyeing of synthetic polymers is to be recommended as an excellent fundamental introduction to the subject.

There are certain minor criticisms, but attention should be directed here to the equation on p 382 It might have been more satisfactory to relate the denier of the spun yarn to the rate of take-up T at the final godet in metres/min, the pump throw D in c c /min, and n the number of filaments in the jet (x and r are as defined in the book), that is

$$\text{filament denier} = \frac{9\ \ 10^3\ \ D x}{n T}\ \ \frac{(100 + r)}{100}$$

This equation would then be more readily correlated with the statement on p 369, l 8

The chapters on crystallinity, etc, are excellent and give a clear picture of our present knowledge on the structure of these polymers Personally, I would prefer to see the X-ray diagrams reproduced as black reflexions on a white ground The fundamental chemistry of polymer synthesis is well covered, but in the chapter on the theory of polymer solutions the derivation of the usual fundamental thermodynamic equations might have been shortened

In conclusion, however, the editor and his collaborators are to be complimented on their achievement, and if one finds the work exhaustive, it is an excellent source of information for the student, and may well become a standard reference for all workers in the field of synthetic polymers F Happey

KERNEL FUNCTIONS

Kernel Functions and Elliptic Differential Equations in Mathematical Physics

By Stefan Bergman and M Schiffer (Pure and Applied Mathematics Series, Vol. 4) Pp. xiii+432. (New York Academic Press, Inc, 1953) 8 dollars.

THE methods initiated about a hundred years ago in the theory of electrostatic potential by the miller-mathematician, George Green, have now considerably developed. The determination of the solution of Laplace's equation which takes prescribed values on the boundary of a domain depends on finding the Green's function for that domain Other boundary value problems depend on the functions of Neumann and Robin These three functions all have singularities, but by taking the difference of two of them we can get rid of the singularity and form what is called a regular kernel function. The whole theory of the elliptic partial differential equations of mathematical physics can be based on the properties of these functions, which have been the subject of much recent research by the authors and others.

This book consists of two parts the first mathematical physics, the second pure mathematics. The first part contains four chapters, dealing respectively with the conduction of heat, fluid dynamics, electro- and magneto-statics, and elasticity In these chapters the fundamental solutions of the differential equations are introduced in a way which points out their physical significance The second part of the book contains an exact mathematical discussion of the kernel functions satisfying a partial differential equation rather more general than Laplace's equation. In addition to existence theorems, there are identities and developments in series which can be used for numerical computation Variational formulæ are obtained which throw light on problems of stability

The book requires considerable preliminary knowledge, including the theory of integral equations, but it will be very useful to advanced students who desire a guide to recent research on kernel functions, with an indication of opportunities for further advances There is an elaborate index and a very full bibliography of books and research papers

H T H Piaggio

CHEMICAL ENGINEERING

Chemical Engineering

By Dr. J. M. Coulson and Dr J F Richardson Vol 1 Fluid Flow, Heat Transfer and Mass Transfer. Pp. viii+370+16 plates (London Pergamon Press, Ltd., New York McGraw-Hill Book Company, Inc., 1954) 38s 6d net.

IT has been a matter of regret that few text-books dealing with chemical engineering subjects have been published in Great Britain, but recently there have been available from British sources two good text-books in elementary chemical engineering The present book is much more comprehensive, and Vol 1 now published is divided into four sections fluid flow, heat transfer, mass transfer and humidification and water cooling. The second volume will deal with the physical principles of chemical process design, such as distillation, drying and evaporation, liquid–liquid extraction, and adsorption and mixing and separation.

Each section of the book includes a theoretical treatment leading to the discussion of the practical applications and to worked examples. The diagrams and illustrations of various forms of chemical engineering apparatus have been very skilfully selected. Each chapter or each section includes a list of modern references and of symbols Mathematical treatment is given fully in order that it can be applied to a variety of problems the more difficult theoretical sections have been put into small print.

A fairly complete discussion is given of the boundary layer in the section on momentum, heat and mass transfer, but this relates primarily to flat surfaces and flow in tubes, whereas flow patterns around curved surfaces such as cylinders or spheres are not discussed. There is a brief discussion of flow convection across cylinders in an earlier section on heat transfer, but no reference is made to pipe stills Flow patterns around spheres are of some importance in connexion with the diffusional problems to be discussed in the next volume and might well have been included in the chapter on the boundary layer

The book is based on a course of lectures given over a period of years and can be strongly recommended The price is reasonable and the book is well produced and has a good index.

F H Garner

RECENT INFRA-RED AND X-RAY STUDIES OF COAL

By J. K. BROWN
British Coal Utilization Research Association, Leatherhead
AND
P. B. HIRSCH
Crystallographic Laboratory, Cavendish Laboratory, University of Cambridge

Introduction

THE purpose of this article is to describe the results of recent infra-red and X-ray measurements on coals, to summarize briefly the joint conclusions, and to compare them with those of other investigators More detailed accounts of the infra-red and X-ray work are being published elsewhere[1]

Coals form a series ranging from peats, through the lignites to bituminous coals and anthracites (for details concerning the classification of coals, see ref. 2). Geological evidence suggests that this series represents a continuous and progressive change, the metamorphic process is termed 'coalification'. The three main chemical elements which occur in coals are carbon, hydrogen and oxygen. As the degree of coalification increases, there is an increase in the percentage of carbon and a decrease in the percentages of hydrogen and oxygen Microscopic examination of coals shows that they consist of a number of different components of which the most homogeneous is vitrain, it is a major constituent of the bright coals. A range of vitrains with carbon contents between 78 and 94 per cent (by weight, dry basis, free from mineral matter) has been studied in the present work.

Chemical Structure

The major chemical constituent of all coals is carbon Both chemical and infra-red spectroscopic measurements agree in showing that a large proportion of this carbon occurs in aromatic systems, and there is strong evidence that at least some of this is in the form of condensed rings[3]. The sizes of the condensed aromatic ring clusters in a coal of approximately 85 per cent carbon content have been estimated previously both by chemical[4] and X-ray methods[5]. Chemical investigations of the hydrogenation products[4] indicate that systems containing between two and six condensed aromatic rings predominate, whereas X-ray diffraction line-widths have been interpreted in terms of 'graphitic' layers of approximately 20 A. diameter, this corresponds to some fifty condensed rings

The present X-ray work has been carried out in more detail than was previously attempted The results show that approximately 75 per cent of the carbon is in the form of condensed aromatic units, and that for a coal of 85 per cent carbon content these contain about four or five rings This result, which agrees with the conclusions from chemical studies, applies to the *whole* of the coal The remainder of the carbon and the other atoms are effectively disordered

Although it has not been possible to deduce from the infra-red spectrum that ring clusters of the above size exist in the structure, the results are consistent with this estimate The value of the infra-red method is that it can give information, which cannot be obtained from the X-ray scattering, concerning the nature of the disordered material Thus the X-ray and infra-red methods are complementary. The disordered material is assumed to be in the form of chemical groupings which are attached to the condensed aromatic rings For example, the analysis of the spectrum of a coal of 85 per cent carbon content shows that aromatic material is present together with saturated aliphatic (and possibly alicyclic) groupings. The weakness of the absorption bands which arise from aromatic C—H bonds compared with those arising from ring vibrations suggests strongly that the aromatic rings are highly substituted The ratio of aliphatic to aromatic C—H bonds has been estimated to be approximately 4 1 for this coal

The infra-red spectrum shows that oxygen is present in hydrogen-bonded phenolic hydroxyl groups Oxygen in aromatic ether or polycyclic quinone structures is believed to cause the observed considerable enhancement of the intensity of the aromatic ring vibration absorption band near 1,600 cm.$^{-1}$ More will be said about these forms of oxygen in connexion with the changes in the spectra with carbon content Cannon[6] has made an assignment of the main absorption bands in coal spectra and has reached some of the conclusions discussed here The chief difference is that he has reported the occurrence of aldehyde or keto groups and ester groupings in the structure These have not been detected in any of the coals studied in the present work, we suggest that the discrepancy may be due to the fact that Cannon's samples were not pure vitrains.

Changes in Chemical Structure with Carbon Content

X-ray methods have been used for measuring the sizes of the condensed aromatic ring clusters for the complete range of coals. The results are shown in Fig. 1, where the diameters and the numbers of rings in the layers are plotted against the carbon content Below about 89 per cent carbon the variation in the number of rings in each unit is small, but at carbon contents higher than this value the size of the ring clusters increases rapidly. The type of variation shown in Fig 1 has previously been reported by Blayden *et al* [5], but, as stated earlier, the number of rings in each condensed unit found by these workers was very much larger than that deduced from the present work. The possible error in measuring the proportion of ordered carbon (± 20 per cent) is too large to permit the determination of the variation of this quantity with carbon content Several workers[7-10] have used statistical methods based on ultimate analyses, helium densities, refractive indices and calorific values of coals in order to estimate the sizes of the condensed aromatic systems and the proportion of aromatic carbon. These methods give a variation of ring size with carbon content of the type found in the present X-ray work, although these estimates are in general somewhat high, the values obtained from refractive indices[8] and calorific values[10] are of the same order of magnitude as those found in the present work.

The infra-red spectra of the range of vitrains have been studied, in order to follow the changes in

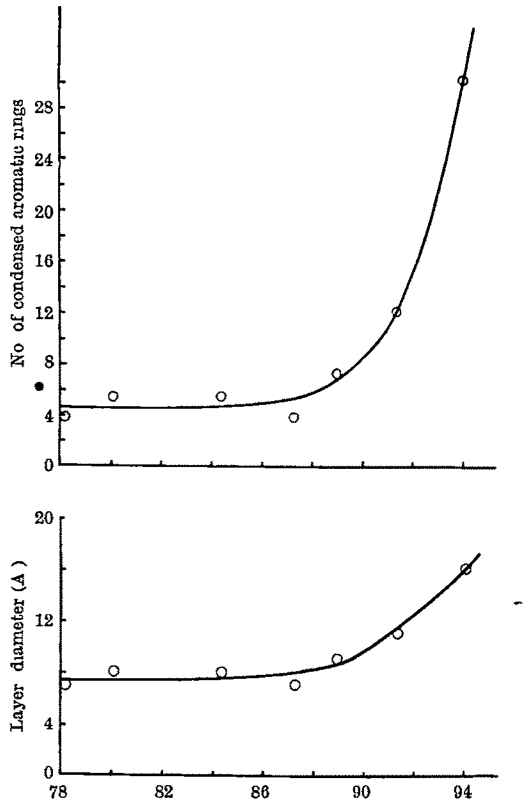


Fig 1 Layer diameter and number of condensed aromatic rings as a function of carbon content

intensity of absorption bands assigned to substituent groups and to examine the variation in aromatic substitution which accompanies these changes

The absorption bands which arise from hydrogen-bonded OH groups are very strong in vitrains of 78 per cent carbon content. With increasing carbon content the intensity of these absorption bands decreases until at 89 per cent carbon they are very weak In these latter coals the concentration of hydroxylic material must be small. The intensity of the 1,600 cm.$^{-1}$ absorption band which, as stated earlier, is believed to arise from the presence of aromatic ethers and/or polycyclic quinones, undergoes remarkably little change with carbon content, this suggests that these structures occur throughout the range of coals, except possibly in the anthracites (94 per cent carbon), where it was impossible to estimate the intensity of the absorption band In view of these observations, it is suggested that the decrease in oxygen to carbon ratio between 78 and 93 per cent carbon is due mainly to the loss of OH groups.

The ratios of the optical densities of absorption bands arising from aromatic and aliphatic C—H vibrations, D_{ar}/D_{al}, have been measured for vitrains with carbon contents between 84 and 93 per cent The results are shown in Fig 2 An approximate ratio of the extinction coefficients for these absorption bands has been obtained from the study of a number of alkyl substituted and hydro-aromatic condensed compounds From this value the relative numbers of aromatic and aliphatic C—H bonds have been calculated for the coals This estimate gives directly the ratio of the aromatic to aliphatic hydrogen, and from these results it is a simple matter to calculate the ratio of aromatic hydrogen and aliphatic (or alicyclic) hydrogen to carbon from the known total hydrogen to carbon ratios (These ratios have been corrected for hydrogen in the form of OH groups on the assumption that all of the oxygen occurs in this form, the infra-red data suggest that this assumption is not strictly true, but the error involved is very small) Fig 3 shows that the aromatic hydrogen increases while the aliphatic hydrogen decreases with increasing carbon content The increasingly rapid rate of loss of aliphatic groups at carbon contents greater than 89 per cent must account for the very marked decrease in the ratio of total hydrogen to carbon observed in that range Although accurate measurement of D_{ar}/D_{al} at 94 per cent carbon was not possible, the spectra indicate that the amount of aliphatic material is very small for these coals Also, at 94 per cent carbon, the spectra suggest that there is a decrease in the aromatic hydrogen content

Assuming that the amount of aliphatic carbon is half that of the aliphatic hydrogen (that is, that CH_2 groups predominate) the fraction of aromatic carbon can be calculated. The results are shown in Fig 4 (Using a somewhat different approach, Dryden[11] has calculated upper and lower limits of the fraction of aromatic carbon, the present results fall within this range) The fraction of aromatic carbon increases from a value of approximately 0 72 at 84 per cent carbon to 0 92 at 93 per cent carbon. Van Krevelen and Chermin[12] have estimated the fraction of aromatic carbon on the assumption that the volatile matter arises from the aliphatic material; their results are also given in Fig 4 and are seen to be in good agreement with the present estimates The values estimated from the X-ray scattering (75 ± 20 per cent) are also of the same order of magnitude

The variation in aromatic substitution with carbon content has been studied by analysing the pattern of absorption bands between 700 and 900 cm^{-1} At the beginning of the range of carbon contents (78 per cent carbon), the degree of substitution is high, with increasing percentage of carbon content it decreases, in agreement with the observation that the amount of aromatic hydrogen increases Part of this decrease in substitution is most probably due to the loss of phenolic OH groups, and the remainder results from the removal of some aliphatic material. Between 89 and 93 per cent carbon, the degree of substitution

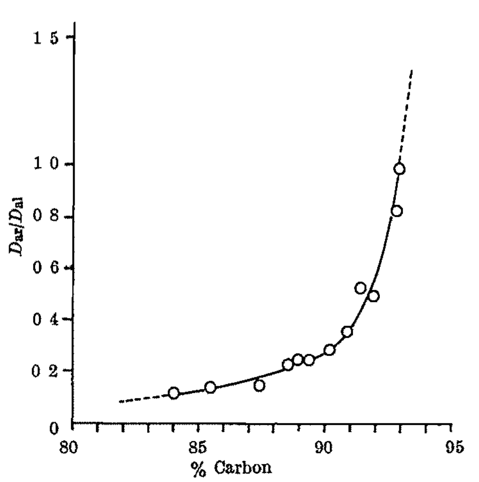


Fig 2 Ratio of optical densities of aromatic and aliphatic C—H stretching absorption bands as a function of carbon content From Brown, J K, "Infra-red Spectra of Coals", *J Chem Soc* (in the press)

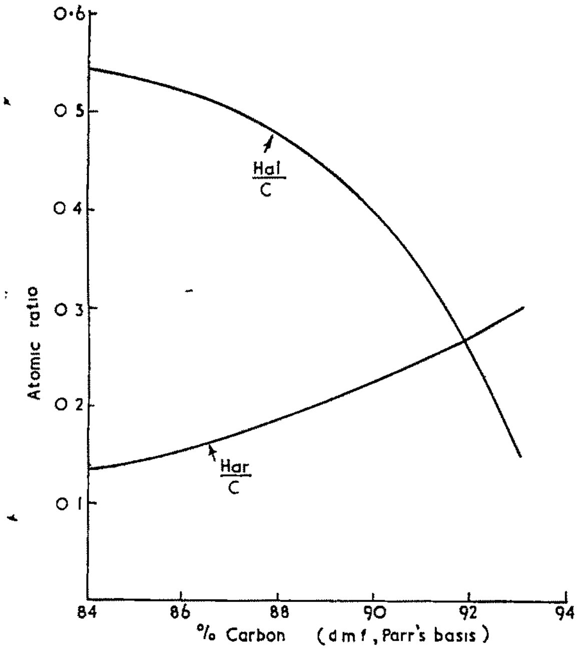


Fig. 3. Variation of the ratio of aliphatic, H_{al}, and aromatic hydrogen, H_{ar}, to total carbon, C, with carbon content

decreases, mainly due to the removal of aliphatic groups. At 94 per cent carbon the analysis shows that aromatic rings which contain isolated C—H bonds predominate in the structure. This result, when considered in conjunction with the fact that only a very small amount of aliphatic material is present, suggests strongly that large condensed aromatic systems occur; these would be expected to contain a high proportion of such rings on their periphery.

In addition to the changes which have been discussed above, the spectra also show a structureless background absorption. The intensity of this background absorption is low in the spectra of vitrains with carbon contents up to approximately 89 per cent, but then shows a marked increase and becomes very high at 94 per cent carbon. In agreement with a previous suggestion by Cannon[6], the effect was thought to arise from an electronic absorption band which moves from the visible across the infra-red region with increasing carbon content. It was believed to result from the growth in size of the condensed aromatic structures. Recent work by R. R. Gordon et al. (*Nature*, 174, 1098; 1954), however, strongly suggests that the structureless background 'absorption' arises from the scattering of radiation and is not of electronic origin.

Packing of the Condensed Aromatic Layers

Evidence for the packing of the aromatic layers in coal structure comes from a detailed analysis of the X-ray data. This concerns in particular the band at 3·5 A. (002 band), a peak at 20 A. and the diffuse scattering at lower angles. By analogy with the structure of amorphous carbon[13], the 002 band is considered to be a consequence of the packing of the aromatic layers parallel to each other in small groups. The layers, however, have no particular orientation relative to each other about an axis normal to their plane (turbostratic packing[13]) and they may be displaced parallel to each other. Fourier analysis of the 002 band shows that, in a vitrain of approximately 85 per cent carbon content, about 60 per cent of the layers occur singly, 28 per cent in groups of two, and the remainder in groups consisting of a larger number of units. With increasing carbon content the order improves; the proportion of single layers is reduced and the fraction in larger groups increased; but even at approximately 89 per cent carbon, about 45 per cent of the layers occur singly. By far the most frequently occurring *parallel group* in all the coals consists of two layers.

The layers have a preferred orientation parallel to the bedding plane; the preferred orientation is small but measurable even in the coals of smallest carbon content studied. The orientation improves with increase in the carbon content of the vitrain, the effect being particularly marked in coals with carbon contents greater than 89 per cent. The layer spacing is about 3·52 A. for the coals between 84 and 92 per cent carbon; in vitrains with smaller percentages of carbon, the spacing is considerably greater (~3·7 A.). At the upper end of the range (near 94 per cent carbon) the spacing is reduced to 3·43 A., that is, close to that observed for pure amorphous carbon.

At lower angles the intensity of the diffuse scattering decreases with increase in carbon content up to approximately 89 per cent carbon. Beyond this value it increases again. There is a close similarity between the behaviour of the diffuse scattering and the porosity of the vitrains[14], which suggests that it arises from pores. The shape and intensity of the low-angle scattering curves for coals with carbon contents of approximately 85 per cent suggest that there is a very wide distribution of pore diameters; this distribution extends from a few angstroms to values greater than 5000 A. Wide distributions of pore sizes have also been found from recent surface-adsorption measurements[15]. A measurement of the intensities and shapes of the low-angle scattering curves suggests that at least some of the pores have a disk shape and are oriented parallel to the bedding plane. The X-ray scattering is not consistent with the Bangham model[16] of close-packed micelles of approximately 200 A. diameter.

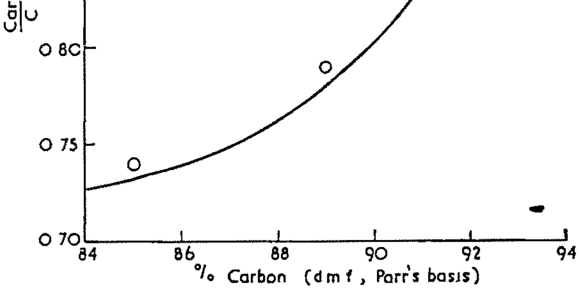


Fig. 4. Ratio of aromatic to total carbon for a range of vitrains. ——, from present work; O, Van Krevelen and Chermin (ref. 12)

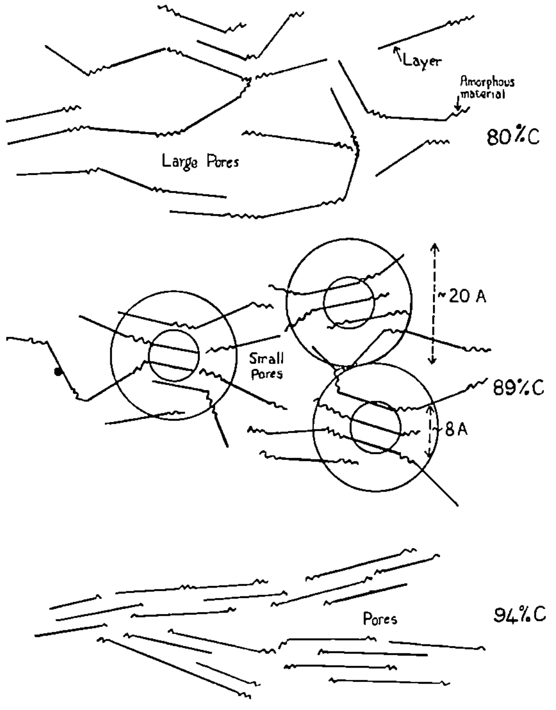


Fig 5 Schematic diagram of the packing of coal molecules at various stages during the process of coalification

For coals with carbon contents greater than about 84 per cent, a peak appears in the scattering curve which corresponds to a spacing of 20 A. This peak is most pronounced in vitrains with carbon contents near 89 per cent and then decreases again in intensity. An analysis of the Fourier transforms shows that the peak arises from units of overall diameter $\sim$ 20 A, the density of which varies continuously from the centre outwards, and which contain a central dense core of diameter $\sim$ 8 A, both parallel and perpendicular to the bedding plane This central core is considered to be a group of two completely overlapping graphitic layers, the dimensions of which are also of $\sim$ 8 A. The rest of the unit consists of layers which are either displaced parallel to each other or misorientated, and of the amorphous material which is considered to be in the form of substituted groups. Fig. 5 shows the type of packing envisaged. The distance from centre to centre of neighbouring layers is only $\sim$ 10 A , the fact that the layers surrounding the core cannot pack tightly suggests (but does not prove) that neighbouring layers are chemically linked by bonds which enforce a buckling of the structure Density considerations indicate also that, for vitrains with 89 per cent carbon, micropores of $\sim$ 10 A diameter occur in the structure The existence of such micropores has also been indicated from the results of recent gas and liquid absorption measurements[15,17].

At least some of the units appear to be close-packed at distances of $\sim$ 20 A , but the ordering is poor as in a liquid The 'liquid-like' structure is continuous over distances of the order of microns. Beyond 89 per cent carbon the 20 A peak becomes less pronounced and the diffuse scatter at low angles increases The Fourier transforms indicate that some of the units containing the 8 A core still persist, while the average diameter of the 'graphitic' layers at 94 per cent carbon determined from the scattering at high angles is now found to be $\sim$ 16 A. It is suggested that locally there remain regions in the coal where 8 A. diameter lamellæ occur in groups of diameter 20 A , but that in other parts of the structure several lamellæ have grown together to form larger graphitic layers This process is accompanied by a flattening of the structure , there is an improvement of the local parallel packing of the layers, which must have the consequence of enlarging the pores in neighbouring regions, giving rise to an increase in the intensity of diffuse low-angle scattering. Such a 'clustering' process will result in a wide distribution of layer diameters , this conclusion is in good agreement with the shapes of the bands at high angles. The clustering of the condensed aromatic structures in vitrains with carbon contents greater than 89 per cent takes place particularly rapidly between 92 and 94 per cent carbon

The arrangement of the aromatic layers in coals with different carbon contents is shown in Fig 5.

The Coalification Process

The infra-red and X-ray measurements will now be considered together to obtain a more complete description of the coalification process Between 78 and approximately 89 per cent carbon, the sizes of the condensed aromatic ring systems in coal structure increase only slightly , the units consist of four to five rings up to approximately 87 per cent carbon, increasing to about seven rings at 89 per cent carbon. This change is accompanied by a small increase in the aromatic carbon and hydrogen and a small decrease in the aliphatic hydrogen contents.

There is a gradual improvement in the molecular packing with increasing carbon content ; as a result of this, a 'liquid-like' structure is formed and all the large-scale pores disappear. An important chemical change which occurs in this range of coals involves a very marked reduction in the number of hydrogen-bonded OH groups in the system. At carbon contents near 89 per cent, the infra-red results indicate that the phenolic content must be small At this stage the 'liquid-like' packing is at its best and the porosity is a minimum It is reasonable to suggest that the large reduction in the number of hydrogen-bonded groups is connected with the improvement in packing of the condensed aromatic layers.

Between 89 and 94 per cent carbon, the aromatic layers grow rapidly in diameter and a wide distribution of layer sizes is observed. This is accompanied by a large increase in the proportion of aromatic carbon in the structure and a corresponding decrease in the aliphatic (or alicyclic) content. The aromatic hydrogen shows an increase up to 93 per cent carbon , at 94 per cent carbon some decrease is observed The 'liquid-like' structure present at 89 per cent carbon gradually disappears with increasing carbon content, and pores are produced

It is not possible to consider in detail the process by which the aromatic layers increase in size with carbon content However, it is clear from the quantitative estimates of the proportions of aliphatic and aromatic carbon that the aliphatic material associated with each cluster cannot alone produce the number of rings required to account for the increase. In order to produce this very marked increase, two or more neighbouring layers must coalesce to form larger perfect condensed sheets. It is likely that this is accompanied by an aromatization of at least some of the aliphatic or alicyclic groupings A consideration of the X-ray results for vitrains in the range 89–94 per cent carbon has already led to the conclusion that a local condensation of the layers takes place with increasing carbon content. It seems most probable that the much smaller increase in layer diameter observed between 87 and 89 per cent carbon also occurs in this way. The formation of the large condensed aromatic structures in the anthracites (94 per cent carbon) has been accompanied by the loss of some aromatic hydrogen, which presumably has been eliminated from the rings during the condensation process.

Although the changes during coalification have been to a large extent considered separately for the regions 78–89 per cent carbon and 89–94 per cent carbon, there is no reason for believing that there is any discontinuous transition between the two. The regions have been separated so that the major changes which occur could more readily be discussed.

Conclusion

The model which has been put forward in the preceding discussion is intended to act as a guide in the interpretation of future chemical and physical investigations of coal constitution. It is tempting to suggest detailed chemical structures which are based on the proportions of substituent groups deduced from the infra-red work However, it is felt that any such attempt would be premature—and possibly misleading—at the present stage A number of structures have been tried which are consistent with all the data, and from these it is clear that the aliphatic chains must be short, it is possible also to obtain consistency if alicyclic rings are present. However, there are many problems concerning the detailed configurations which remain to be solved One of the most important of these is to determine whether the condensed aromatic systems are linked by chemical bonds in a polymer-type structure, or whether they occur mainly as isolated units Consideration of the origin of the 20 A. band which occurs in the X-ray diffraction pattern from coals with carbon content between $\sim$ 86 and 94 per cent carbon suggests that some of the layers may be linked to form a structure extending over at least 20 A Both X-ray[18] and infra-red studies of solvent extracts[19] obtained at moderate temperatures show that they contain structures very closely related to the main part of the coal A polymeric system is expected to behave in this way, the extraction being mainly on a molecular-weight basis. It should be noted that the possibility of aromatic ethers existing in the structure of a wide range of vitrains does suggest that some linking of the units by oxygen may occur The infra-red evidence for such linkages in the solvent extracts is the same as that in the coals. Molecular weights of extracts in various solvents have been quoted by a number of workers[20], they range from approximately 250 to 4,000 The units consisting of approximately four condensed rings substituted by aliphatic and OH groups found in the present work would have molecular weights at the lower end of the above range The higher molecular weights may be due to cross-linked layers, or to physical aggregation

The low density of coals (c 1 3) when compared with that of graphite (c 2 2) is quite compatible with the suggested structure. It arises from the poor packing of the molecules which results in micropores The porosity observed experimentally is mainly the consequence of a wide distribution of larger pores, some of which are disk-like. But even in vitrains of approximately 89 per cent carbon, where the porosity is very small, there must exist micropores (c. 10 A diameter and less) in the 'liquid' structure.

The decrease in the strength of coals (as measured by Young's modulus[7,21], grindability index[22] and viscosity[7]) with carbon contents up to 89 per cent seems to follow, and may be a result of, the gradual disappearance of groupings which form strong intermolecular hydrogen bonds The greater strength of the anthracites is doubtless a result of the increasing forces between the larger flat condensed structures

The variation in the optical properties, for example, birefringence, refractive index and absorption coefficient[7,23], of the vitrains with carbon content can be accounted for, at least qualitatively, in terms of the model proposed But the reason for the dark colour of the coals is not yet clearly understood.

One of us (P. B. H.) wishes to thank Sir Lawrence Bragg and Dr. W. H. Taylor, in whose laboratory the X-ray work was carried out, for constant help and encouragement, he is also grateful to Sir Charles Ellis for initiating the X-ray work, to the National Coal Board for financial assistance, and to the managers of the I C I Fellowship Fund of the University of Cambridge for the award of a Fellowship.

The other (J. K. B) is grateful to Prof. F. J. W. Roughton and Dr N. Sheppard for the facilities afforded in the Department of Colloid Science, Cambridge, and to the members of the British Coal Utilization Research Association, Leatherhead, in particular to Dr I G. C Dryden, for constant advice and encouragement. He would also like to thank the Association for permission to publish this communication.

We thank Dr G W Fenton and Mr J W Fowler, of the Coal Survey Laboratory, Sheffield, and Dr. I. G. C. Dryden, of the British Coal Utilization Research Association, for providing specimens of pure vitrains

[1] Brown, J K, *J Chem Soc* (in the press) Hirsch, P B *Proc Roy Soc*, A, **226**, 143 (1954)

[2] Raistrick, A, and Marshall, C E, "The Nature and Origin of Coal and Coal Seams" (English Universities Press, Ltd, London, 1952)

[3] Bone, W A, Parsons, L G B, Sapiro, R H, and Groocock, C M, *Proc Roy Soc*, A, **148**, 492 (1935) Howard, H, *Indust Eng Chem*, **44**, 1053 (1952)

[4] Le Claire, C D, *J Amer Chem Soc*, **63**, 343 (1941) Biggs, B J, *J Amer Chem Soc*, **58**, 484 (1936)

[5] Blayden, H E, Gibson, J, and Riley, H L, Proc Conf Ultra-fine Structure of Coals and Cokes, 176 (B C U R A, 1944)

[6] Cannon, C G, *Nature*, **171**, 308 (1953)

[7] Van Krevelen, D W, *Brennst Chem*, **34**, 167 (1953)

[8] Schuyer, J, and Van Krevelen, D W, *Fuel*, **33**, 176 (1954)

[9] Dryden, I G C, and Griffith, M, *Fuel*, **32**, 199 (1953)

[10] Dryden, I G C, *Fuel* (in the press)

[11] Dryden, I G C, *Fuel* (in the press)

[12] Van Krevelen, D W, and Chermin, H A G, *Fuel*, **33**, 338 (1954)

[13] Biscoe, J, and Warren, B E, *J App Phys*, **13**, 364 (1942)

[14] Franklin, R E *Trans Farad Soc*, **45**, 274 (1949) King, J G, and Wilkins, E T, Proc Conf Ultra-fine Structure of Coals and Cokes, 46 (B C U R A, 1944)

[15] Zwietering, P, and Van Krevelen, D W, *Fuel*, **33**, 331 (1954)

[16] Bangham, D H., Franklin, R E, Hirst, W, and Maggs, F A P, *Fuel*, **28**, 231 1949)

[17] Bond, R L (private communication)

[18] Hirsch, P B (unpublished work)

[19] Cannon, C G, and Sutherland, G B B M, *Trans Farad Soc*, **41**, 279 (1945). Brown, J K (unpublished work)

[20] Howard, H, *J Phys Chem*, **40**, 1103 (1936) Orchin, M, Golumbic, C, Anderson, R B, and Storch, H H, U S Bur Mines, Bull 505 (1951) Wynne-Jones, W F K, Blayden, H E, and Shaw, F, *Brennst Chem*, **33**, 201 (1952)

[21] Bangham, D H, Proc Conf Ultra-fine Structure of Coals and Cokes, 18 (B C U R A, 1944)

[22] Dryden, I G C, *Fuel*, **30**, 217 (1951)

[23] Cannon, C G, and George, W H, Proc Conf Ultra-fine Structure of Coals and Cokes, 290 (B C U R A, 1944)

BRITISH-KENYA MIOCENE EXPEDITIONS

INTERIM REPORT

IN the summer of 1947, following the first Pan-African Congress on Prehistory, held in Nairobi, and the opportunity provided on that occasion for the examination of the important Lower Miocene fossil Primates already found in Kenya and for visits by members of the Congress to the sites where they were collected, the Royal Society made a grant of £1,500 to enable more intensive investigations to be carried out by geologists and palæontologists The results of these investigations were eminently successful, and adequate annual grants for their continuation were afterwards made available by the Kenya Government, supplemented by some private benefactions In particular, a motor launch was provided by the generosity of Mr C. W. Boise to facilitate visits to the fossiliferous islands in Lake Victoria It seems appropriate, now that seven years work has been completed, that a brief summary should be given of the results so far achieved

The total number of specimens from Lower Miocene deposits obtained during this period exceeds fifteen thousand The majority of these were recovered from sites on Rusinga Island and Mwafangano Island, and others have been found at sites of similar age on the mainland ranging from Karungu in the south to Muruorot (west of Lake Rudolph) in the north The specimens cover a very wide range of material, vertebrate and invertebrate, as well as the fossilized remains of the contemporary vegetation So far as the mammalian material is concerned, in some respects the most interesting are the fossil Primates. These include the nearly complete skull of *Proconsul africanus* (the only specimen of the skull of a Miocene ape so far known), an abundant collection of jaws and teeth of this genus as well as some of the limb bones (including a complete hand skeleton), jaws and teeth and limb bones of a primitive gibbon-like ape *Limnopithecus*, and also remains of cercopithecoid monkeys and lemuroids. Other mammalian fossils include representatives of many different orders, ranging from small insectivores and rodents to anthracotheres and proboscidians The vertebrate collections also include many specimens of reptiles and fishes The Early Miocene invertebrate fauna is represented by a wide range of Mollusca, numerous Myriapoda, a few Crustacea, and a remarkably well-preserved collection of fossil insects and allied groups Finally, the material includes a large series of fossil fruits and seeds representative of an extensive flora

The study of these collections of Lower Miocene material is being undertaken by a number of specialists, and already several reports have been published in a series of monographs issued by the British Museum (Natural History) under the general title "Fossil Mammals of Africa". So far, the published reports have dealt with the Hominoidea, Lemuroidea, Anthracotheroidea, Lagomorpha and Hyracoidea Other monographs in the press are concerned with the Insectivora, Tubulidentata, Ruminantia, and with an almost complete skull of a Miocene lorisiform Lastly, reports are in course of preparation on the Rhinocerotidae, Suidae, Cercopithecidae, Carnivora and Rodentia, as well as on the fossil reptiles, Myriapoda and the flora

The geological work of the British-Kenya Miocene Expeditions has involved detailed field-mapping by Prof R Shackleton, Dr T Whitworth and Mr I. Higginbottom, and the results of these studies (which have appeared as a series of papers in the *Quarterly Journal of the Geological Society*) demonstrate the relationship of the Miocene beds to other formations as well as the complex stratigraphy of the fossiliferous deposits themselves

In addition to the main excavations, reconnaissance visits have been made to two regions containing Miocene deposits in the Northern Province of Kenya, and to a supposed Lower Miocene area near Maralal (which, however, is more probably of Pliocene age) Small collections were made at these sites, but none of them proved to be rich in fossils Excavations carried out on Maboko Island have established that the deposits at this site are only partly of Lower Miocene age , other beds there are evidently of later date, though they contain some true Miocene fauna as derived fossils Lastly, an extensive survey, made possible by the motor-launch, has been carried out on numerous islands in Lake Victoria in order to determine the western extension of the Lower Miocene deposits The latter do not appear to extend beyond Mageta Island (but here they are unfossiliferous)

The following have taken part in the field-work of the British-Kenya Miocene Expeditions during the past seven years Dr and Mrs L S. B Leakey, Dr D G MacInnes, Prof R Shackleton, Dr T Whitworth, Mrs Coryndon, Mr I Higginbottom, and also a trained group of African field-workers Among visiting scientists who have examined parts of the area are (the late) Miss D M Bate, Prof D M. S Watson, Dr K. P Oakley and Prof G H R von Koenigswald.

The work of the expeditions is being continued as circumstances permit But it is already possible to say that the Kenya Lower Miocene deposits provide one of the most complete records of the fauna and flora of the period, and for the first time present a full picture of the terrestrial and freshwater life of the Lower Miocene in the African continent

L S B Leakey
W E Le Gros Clark

THE PHOTOGRAPHIC PROCESS

THE appearance of a second edition of C E K. Mees's "The Theory of the Photographic Process"* provides an occasion for a review of the present state of our knowledge of this subject, and especially of the nature of the photographic latent image and its formation by exposure to light But in doing so, the reviewer does not wish to imply that the discussion of a theory in any such narrow sense forms the main or necessarily the most important part of this massive volume of more than a thousand pages Written by the vice-president in charge of research in the Eastman Kodak Company in collaboration with more than twenty of his colleagues, it must be taken to represent the considered view of the Company on all scientific aspects of photographic materials and of the action of light on them. There are particularly valuable sections on optical sensitizing, development and sensitometry, and there are new chapters dealing with the action of charged particles and of X-rays on photographic emulsions. The whole book contains a very large amount of experimental material which is both of practical value and relevant to any discussion of the principles involved in the process.

---

* The Theory of the Photographic Process By Dr C E Kenneth Mees, F R S Revised edition Pp x+1133 (New York The Macmillan Company, 1954) 21 50 dollars

But any attempt to understand what happens in photographic emulsions is faced by the difficulty that emulsions differ so much from one another. One is therefore tempted to make use of experiments on large crystals of silver bromide and similar materials, such as those carried out in Gottingen between the two World Wars by R. W. Pohl's school and more recently by J. W. Mitchell and his colleagues at Bristol, the latter experiments making use of sensitized as well as pure crystals and being specially designed to throw light on the photographic process.

In 1938 the late R. W. Gurney and the reviewer published a theory of the photographic process which was based on three results of the Gottingen school. These are, that silver bromide crystals show photoconductivity, that the range of the photo-electrons is decreased when colloidal metal is present, and that silver bromide shows ionic conductivity at room temperature or above. It was therefore proposed that the primary action of the light was to produce photo-electrons, that these electrons were trapped by any metal particles already formed or by 'sensitivity specks', believed to be silver sulphide, and that the negative charge was then neutralized by the movement of silver ions. In this way, starting from a nucleus of silver or of sulphide of perhaps only molecular dimensions, a speck would grow which would first serve as a latent image and finally become visible under the microscope. The 'positive hole' left behind by the electron was supposed to move about by electron transference until it reached the surface of the grain, when a bromine atom would escape, normally at a point quite distant from that where the silver was formed. This theory stimulated a good deal of experimental research, particularly in the Kodak Research Laboratories at Wealdstone and at Rochester. These researches supported the theory, especially the basic assumption that two processes are involved, one electronic and one ionic. The two processes could be separated in time if the initial exposure was made at a low temperature and the emulsion afterwards warmed up.

At the present time it seems that this theory may be correct for the print-out process and perhaps for some emulsions, too. But there is now evidence that the formation of a latent image need not necessarily be accompanied by the separation of any positive and negative charge. Miller and Hamm[1] appear to have established that the photocurrents observed in photographic emulsions by West and Carroll rise slowly over a period of seconds and may continue to rise after the cessation of illumination. This is not the characteristic inertialess behaviour of the photocurrents observed by Glaser and Lehfeldt of the Gottingen school in large single crystals of silver halides. Even here, however, J. W. Mitchell's group has demonstrated the absence of inertialess photoconductivity at low temperatures in some single crystals of pure silver bromide, provided that these crystals had not previously been illuminated at room temperature so as to cause the separation of silver. These results and others suggest that the latent image may be formed by a mechanism in which silver and bromine are produced very close to each other and later diffuse apart. What seems to happen is that, on illumination, an 'exciton' or state of excitation is produced either in the halide or in a sensitizing dye layer, that this exciton can move a considerable distance, and that it eventually gives up its energy at a 'kink site' on the crystal surface or on a dislocation, where a silver atom and a bromine atom are formed. The bromine then escapes into the gelatine or is taken up by a halogen acceptor; the silver atoms form pairs or bigger groups which constitute the latent image.

To make this clear, we must discuss the meaning of the two terms used. An exciton in an adsorbed dye layer is simply an excited molecule and can move through the layer by transferring its energy to any one of its neighbours. In silver bromide we cannot speak of molecules; it is permissible to think of excitons as positive holes bound in the field of electrons. But the result is the same; we have a state of excitation which can move through the lattice.

Certain aspects of the properties of dye-sensitized emulsions provide perhaps the first evidence that a latent image can be formed without photoconduction; as the discussion in Mees's book shows, it is difficult to see how the excitation of a dye molecule can produce a free electron, and the experiments on the photoconductivity of emulsions to which reference has already been made do not appear to have established the existence of inertialess electron currents of the type which would be expected. Moreover, these experiments strongly suggest that pure silver bromide is not a photoconductor at low temperatures, as previously appeared to be the case. The normal process in this substance and other ionic crystals and oxides seems to be as follows. The light is absorbed by the crystal and forms an exciton. If this, during its life-time of not more than 10^{-8} sec., does not 'collide' with an impurity centre, the energy is re-radiated, as light or heat. If, however, it comes in contact with an impurity centre where a loosely bound electron is attached, it can give up its energy so that the electron is released and can take part in a photocurrent. That this occurs is shown particularly clearly by Apker's[2] experiments on alkali halides carried out in the laboratories of the General Electric Company at Schenectady.

We are therefore led to believe that the formation of latent image silver is normally due to the direct action of an exciton on an ion-pair of silver and bromine. Clearly such an ion-pair must be at a 'kink site' if it is to react; by a kink site is meant a site at the end of a row of ions. Such a site may occur on a surface or at a point on a dislocation; in the latter case it is usually called a 'jog'. The energy of the exciton is sufficient to transfer an electron from the bromide to the silver ion; following J. W. Mitchell, we then assume that the bromine atom moves close to the neighbouring surface, so that the electron cannot move back. This is the primary electronic part of the process; eventually the silver atom and bromine separate by diffusion, the silver to join with other atoms of silver to form the latent image, a speck of metal, and the bromine to form molecules which escape. This may well be the mechanism for the formation both of the surface latent image and the internal image, which the work of Hedges and Mitchell[3] shows to be located along dislocations.

For a sensitive emulsion, then, we require two things: an acceptor for the halogen, a role probably taken by the sulphide sensitizer, and some 'rough' regions on the surface, where there are many kink sites close together, so that silver atoms released by the process described above can easily combine. These rough regions are the sensitive parts of the crystal; the work of Mitchell's group shows them to occur, as one would expect, where a substructure or array of dislocations meets the surface. This, at any rate, is what happens in large crystals, and probably in grains of emulsions, too.

A model of this kind seems to fit many of the facts and probably comes nearer to the true mechanism for many actual emulsions than the original Gurney–Mott theory. It is remarkable how an understanding of the photographic process seems to involve all the latest concepts of the theory of solids, from the movement of excitons to diffusion of atoms along dislocations.

N. F. MOTT

[1] Miller, L. E., and Hamm, F. A., *Rev. Sci. Instr.*, **24**, 214 (1953).
[2] Apker, L., and Taft, E., *Phys. Rev.*, **79**, 964 (1950).
[3] Hedges, J. M., and Mitchell, J. W., *Phil. Mag.* (7), **44**, 223 (1953).

OBITUARIES

Prof. A. R. Richardson, D.S.O., F.R.S.

LIEUT.-COLONEL ARCHIBALD READ RICHARDSON, Fellow of University College, London, and the first holder of the chair of mathematics in the University College of Swansea, died recently at his home in Cape Town at the age of seventy-three. He was educated at the Royal College of Science and University College, London, where he afterwards joined the staff, and in 1912 he was appointed assistant professor of mathematics in the Imperial College of Science and Technology. He had fought as a volunteer in the South African War and was a prominent member of the Officers' Training Corps in the University of London. During the First World War he had a distinguished military career when he commanded the 2/2 and later the combined 2/1 and 2/2 battalions of the London Regiment, but he received serious wounds in the German offensive of March 1918 which permanently affected his health. Shortly before his appointment to Swansea in 1920, Colonel Richardson held the chair of aeronautical science at the Cadet College, Cranwell.

Richardson's early work showed his versatility as a mathematician, for he came to Swansea with a reputation in hydromechanics and an interest in real variable analysis. His first few years at Swansea were occupied by studies on the moment problem, but he soon turned his attention wholly to the rich, and at that time largely unexplored, field of modern algebra, becoming a pioneer and leader in a branch of mathematics then almost entirely neglected in Britain. The twenty-two papers published since his appointment to the Swansea chair represent a contribution to mathematics out of all proportion to their number. It is the extensive range of subject-matter covered and the originality and novelty of the individual papers that are so striking. The earlier papers dealt with hypercomplex determinants and with concomitants and equations over a division algebra. The theory of group characters and representations owes much to the work he did in the early nineteen-thirties, and his discovery of immanants formed a nucleus around which a host of new results accumulated. He was a pioneer rather than a consolidator, and his attention later turned to the new fields of abstract algebra, groupoids and the composition of cubic and quadratic forms. He retired to Cape Town in 1940 for reasons of health, but continued to prosecute research until shortly before his death on November 4, 1954. He was elected a Fellow of the Royal Society in 1946.

Until he received his war wounds, Richardson had given the same untiring energy to sport and military training that he showed in teaching and research. Few men could have survived the severe wounds and consequent operations which he suffered; and when he found himself restricted to a life of semi-invalidism, his true quality was displayed in the singleness of purpose with which he turned his immense vitality to the purposes of teaching and research. Within a few years of his appointment at Swansea, he had established an honours school of algebra which was outstanding, and it was perhaps unfortunate that so few research students came to Swansea to take advantage of this. While at Swansea he established a tradition of good teaching at all levels in both pure and applied mathematics, and played a considerable part in the development of the College in its formative period, so that many departments besides his own owe much to the traditions he helped to establish.

Prof. Richardson's standards in life were exceptionally high and he was a staunch and generous friend to many. He will be gratefully remembered by the students of the inter-war generations and by his colleagues, who will treasure the memory of his friendship and the hospitality which he and his wife dispensed at Highmead. He is survived by his wife, Dr. Margaret E. A. Richardson, a distinguished linguist and past member of the Swansea staff, whom he married shortly after his appointment to the chair of mathematics.

I am indebted to Prof. D. E. Littlewood, of the University College of North Wales, Prof. Richardson's pupil and collaborator, for his assistance in drawing up an appreciation of the publications in algebra.

R. WILSON

Prof. Douglas McCandlish

DOUGLAS MCCANDLISH, emeritus professor of leather industries in the University of Leeds, who occupied that chair during 1919–49, died at his home in Leeds on December 18. His passing is a sad break in the traditions of this unique Department.

He was born in Leeds on November 5, 1883, of Scottish parents, and joined the staff of Mr. Thomas Fairley, the city analyst of Leeds, on leaving the Leeds Boys Modern School. In 1902, he entered the Yorkshire College and graduated with honours in chemistry in the first degree list issued by the University. He then became demonstrator in the Leather Industries Department. After two years, he decided that he must link up his scientific knowledge with the actual manufacture of leather, and so became chemist to William Paul, Ltd., of Leeds. A year later he accepted an appointment as chief chemist to Messrs. A. F. Gallun and Sons, one of the largest and most scientifically minded tanning companies in the United States of America.

When McCandlish succeeded the late Prof. H. R. Procter in the chair of leather industries in the University of Leeds at thirty-six years of age, he was the youngest professor to be appointed at the University. For thirty years he gathered around him a body of students and research workers, being ably assisted by the late W. R. Atkin, who succeeded him, and the late F. C. Thompson.

Among his contributions to leather science, McCandlish's famous paper on the control of chrome tanning by means of the precipitation point may be mentioned. The Procter–McCandlish method of determining the basicity of chrome tanning liquors is also still being used. He devised a means of counteracting the well-known decay in leather-bound books and furniture, and was instrumental in producing upper leather for boots and shoes which could be decontaminated after exposure to war gases

McCandlish acted as honorary treasurer of the International Society of Leather Trades' Chemists for many years and was appointed president in 1925 He was elected an honorary member of the Society, and also of the American Leather Chemists Association. Among other appointments he held were those of dean of the Faculty of Technology (1938–40), president of the Leeds Caledonian Society (1930–33), chairman of the Appeals Tribunal of the National Assistance Board (Leeds Area) and member of the Conscientious Objectors Tribunal (North-Eastern Area).

Douglas McCandlish was a man of great kindness and will long be remembered by his old students and many friends for his kindly jovial disposition, his readiness to help in times of difficulty, his sound judgment, his work as a trustee of the Belgrave Congregational Church in Leeds, his wide knowledge of leather science and the leather industry, and as a bulwark in maintaining the prestige of the Leather Industries Department of the University of Leeds for so many years

He leaves a widow and a son, Dr A. J McCandlish, who is a medical practitioner at South Milford.

Donald Burton

NEWS and VIEWS

Manchester College of Technology: Prof H Lipson

As part of the programme of expanding the Manchester College of Technology, several new professorial chairs have been created For many years there has been a Department of Physics in the College, but until recently it has been regarded as a service department, it is now proposed to expand it materially, and to raise the status of its head to that of professor Dr. H. Lipson, who has been head of the Department since October 1945, was recently elected to this new office He has been responsible for developing a new university course in applied physics leading to the degree of B Sc.Tech. Prof Lipson went to Manchester in 1936 to work under Prof. W L (now Sir Lawrence) Bragg, and was engaged on an investigation of alloy systems, while at the same time he continued his work on the physical aspects of X-ray diffraction. In 1937 he accompanied Prof Bragg to the National Physical Laboratory and later to the University of Cambridge as an assistant in experimental research in crystallography. In 1939, he was awarded the degree of D.Sc. of the University of Liverpool Prof Lipson has for many years concerned himself with the study of X-ray crystallography, and for the past five or six years he has concentrated his efforts on the development and application of a new optical technique for he interpretation of X-ray spectra, a technique which exploits the fundamental similarity between X-rays and light He has designed a spectrometer or this purpose, and the instrument and his techniques have been copied in many other universities nd research institutions all over the world. It is hoped that his Department will shortly be equipped with a new and much larger version of this apparatus which will materially improve the facilities available or this work It is proposed in the near future, in addition, to develop a new section of the Department which will concern itself with the study of solid-state physics

Dr. M Gordon

A fellowship in textile chemistry in the College f Technology, Manchester, was instituted in 1954, as the result of a gift by Courtaulds, Ltd., and Dr Manfred Gordon, who has recently been appointed to he fellowship, will take up his duties in the summer of 1955 The Research Fellow is to be attached to the Department of Textile Chemistry with the specific duty of engaging in, and encouraging, research in textile chemistry. The College has a long tradition of research in this field and a new dyehouse has recently been built and has been extensively equipped with up-to-date machinery for the bleaching, dyeing, printing and finishing of cloth New research laboratories have also been provided and furnished with apparatus and equipment for the investigation of fundamental problems arising in those processes. Much of the machinery and apparatus has been purchased out of a gift from Messrs Courtaulds. Local industry has not only encouraged this provision but is also actively associated in the development of the new facilities

Dr Gordon is a lecturer in the Royal Technical College, Glasgow, following lengthy industrial research experience in the Chemical Research Division of the Dunlop Rubber Co., and is at present engaged on research work on high polymer chemistry He brings to this new research post a fund of knowledge of industrial research requirements, and acknowledged ability as a director of research projects such as those envisaged in the creation of the fellowship

Fellowships of the College

The College of Technology, Manchester, has recently initiated fellowships to be awarded in recognition of research carried out mainly by those who may have no university degree but possess the associateship of the College. A candidate must have been an associate for at least three years and must present a thesis based on original research, and he will be required to present himself for examination. Further information can be obtained from the Principal, College of Technology, Manchester 1.

Assistant Director of the U S. National Science Foundation: Mr. J M Mitchell

Mr James M Mitchell has been appointed assistant to the director of the National Science Foundation, Washington (Dr. Alan T. Waterman) Mr Mitchell's responsibilities will be largely concerned with the Foundation's programme of fact-finding studies on scientific activities and man-power in government, industry and universities. He is at present deputy assistant secretary of defence. He graduated from George Washington University and also did graduate work at the University of Michigan. He has served as a management consultant, personnel officer and administrator in Federal, State and local governments. During 1940–48 he was executive director of the Civil Service Assembly of the United States and Canada, where he also served as editor of *Public Personnel Review*, and was a member of the United States Civil Service Commission during October 1948–April 1953. He has been a lecturer at the University of Michigan, University of Chicago and Northwestern University.

The Patent Office: Mr. H. S. Gilham

MR. H. S. GILHAM has been appointed assistant comptroller in the Patent Office to take charge of Patents in succession to Mr. J. Norman Brown. Mr. Gilham joined the Patent Office staff as an assistant examiner in 1920 and, except for secondment on duties connected with the Second World War, has served continuously in progressive ranks of the Patent Office examining staff. He served with the Royal Engineers (Special Brigade) and later with the Royal Garrison Artillery in the First World War. He was educated at Queen Elizabeth's School, Gainsborough, and Queen Mary College, University of London (Drapers Scholar). Prior to his present appointment, Mr. Gilham was a superintending examiner in charge of a division of examining staff.

A.R.C. Unit of Reproductive Physiology and Biochemistry

THE Agricultural Research Council, in agreement with the University of Cambridge, has established at Cambridge a Unit of Reproductive Physiology and Biochemistry. Dr. T. R. R. Mann, reader in the Department of Veterinary Clinical Studies, has been appointed director of the Unit. There will be two deputy directors, namely, Dr. A. Walton and Mr. L. E. A. Rowson. Mr. Rowson is also director of the Artificial Insemination Centre of the Cambridge and District Cattle Breeders, Ltd., his services to the Unit will, therefore, be part-time.

Journal of Geophysical Research

IT is reported in the September (59, No. 3, 1954) issue of the *Journal of Geophysical Research* that in spite of substantial subsidies, both in time and money, it has been found impossible to continue to maintain a proper standard of publication without considerable monetary loss. Indeed, recently, in order to reduce costs, several worth-while articles have either had to be refused or delayed substantially in publication. Accordingly, it has been decided to increase the subscription-rates and page-charges of the *Journal* as from the beginning of volume 60 (1955). The new rates are six dollars per annum or two dollars for single copies, the page-rate to the author's organization, to cover partial cost of publication, is eight dollars. The *Journal of Geophysical Research*, it will be recalled, is the continuation of *Terrestrial Magnetism and Atmospheric Electricity*, which had a continued run from 1896 to 1948. It is an international quarterly devoted to the fields of terrestrial magnetism and atmospheric electricity, the ionosphere, solar and stellar phenomena, the upper atmosphere, and special investigations of the earth's crust and interior.

Chemical–Biological Coordination Center, Washington, D.C.

THE Chemical–Biological Coordination Center of the National Research Council was established on July 1, 1946, for research into practical problems involved in assembling and making available information on chemicals and their varied effects on biological systems (including the structures o chemicals, and responses of living organisms, or thei functional units, to chemicals), the fate of chemical introduced into a living system and mechanisms o drug action. The Center is also intended to serve a a repository of information on chemical constitutio and biological activity, both published and unpublished or inaccessible data, and to answer appropriat questions and to sponsor preliminary testing o 'screening' of compounds in this field. A brochur describing the activities of the Center, which i responsible to the executive board of the Nationa Research Council, Washington, D.C., has now bee issued by the Council on behalf of the Center (pp. 33 1954). Besides a list of staff, of publications, and o the screening agencies which carry out the screenin tests, the brochure describes the operation of th Center, including the preparation of the code shee on which information is recorded for each chemical the chemistry and biology codes used by the Cente and the way in which the punched cards and th Center's files are used for answering questions. Th type of questions which the Center will attempt t answer is clearly indicated: they must be concerne with chemical–biological data or sources of chemical required in biological investigations. Complet bibliographies cannot be provided, and question must be formulated so as to be clear, concise, unambiguous and to narrow and define the range o the search requested.

Fossil Mammals of Africa

A RECENT addition to the series of publication issued by the British Museum (Natural History) o the fossil mammals of Africa is No. 8, "An Annotate Bibliography of the Fossil Mammals of Afric (1742–1950)", by A. Tindell Hopwood and J. P Hollyfield (London: Brit. Mus. (Nat. Hist.), 1954 45*s*.). The bibliography is based upon the author working list, and is annotated for zoologists interested in the comparative anatomy, distribution an history of the mammalian faunas of Africa, rathe than for geologists and archæologists. All specie mentioned in each publication cited are listed, an the locality and geological horizon given; sometime an author's opinion is summarized and occasionall a direct quotation is given. The writers' own opinion and comments are concise and informative. Th bibliography is followed by a geographical index fro which anatomical and zoological papers have bee omitted unless they are also of faunistic or stratigraphical interest; a complete systematic index o which the classification is based, with minor alterations, upon that proposed by Simpson in 1945; an a nominal index. This carefully compiled guide t the literature dealing with the fossil mammals o Africa, with its most useful comments, will b invaluable to all workers on the subject, and wi spare them many hours of plodding literary researc

Soil and Vegetation Maps of the Belgian Congo

THE attention of readers is directed to a series o fascicles containing land-usage maps published b the Institut National pour l'Étude Agronomique du Congo Belge—"Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi" (Brussels, 1954) Each fascicle contains a soil and a vegetation map in colour and an explanatory memoir In No 6, which relates to Yangambi, the site of the Institute's main research station, the descriptive matter includes an account of the geology, geomorphology, climate, human and economic geography of the region, together with a classification of the several soil series and of the principal types of vegetation and a bibliography In another of these fascicles, relating to the Mvuasi region in the Bas-Congo, the correlation between soil and vegetation and the utilization of the several classes of soil are considered in some detail

Marsilea Experimental Induction of 'Water' and 'Land' Forms

SPORELINGS of *Marsilea drummondii*, grown aseptically in various concentrations of sugars, especially glucose, have been investigated morphologically and anatomically The results are important in that they shed new light on the factors determining the characteristic features of leaves in water and land forms (A Allsopp, *Ann Bot*, 18, 72, 449, 1954) Corresponding to the features of the external morphology, the anatomy of sporelings from low sugar concentrations (1 and 2 per cent glucose) has many characteristics of the water forms of amphibious plants, while that of sporelings from higher sugar concentrations (4 and 5 per cent glucose) has the characteristics of typical land forms It has been shown that the 'water' forms are not merely reduced forms arising by inhibition of the development of a more complete land form In particular, the direction and duration of cell-division are different in the rhizome apices of the two types of sporeling The view is advanced that the differences between land and water forms are not a result of changes in carbohydrate nutrition, but, in the experimental conditions described, arise in response to differences in the osmotic concentration of the culture medium, which are analogous to the differences in availability of water in normal aquatic and terrestrial conditions.

Laboratory Furnaces

CATALOGUE No 558 (August 1954) issued by Messrs A Gallenkamp and Co, Ltd, 17–29 Sun Street, London, E C 2, describes the wide range of electrically heated wire-wound muffle and combustion types of laboratory furnace now manufactured and available from this Company The Gallenkamp method of construction was originally patented in 1914 and, after the patent rights lapsed, was copied by many other makers The design of all Gallenkamp furnaces has recently been carefully reviewed, and as a result the new catalogue lists an augmented range of furnaces, modern in appearance and incorporating the latest methods of control but maintaining the original features of reliability and long life which have made these furnaces so successful during the past forty years. Asbestolite, instead of sheet steel cases, is now used, and the high-quality wire-wound elements are external to the muffles and tubes so that they are protected from fumes and gases which may arise inside a furnace during operation. Muffle furnaces for use at 1,000° C. are fitted with a silver temperature fuse to protect the winding from accidental overheating Various types of furnaces for general purposes such as incinerations, heat treatments, combustions, ash and fusion-point determinations, dental work and vitreous enamelling, together with indicating, controlling and recording pyrometers are described and illustrated

Bibliography of Seismology

VOL. 14, No. 13, of this important work on pure and applied seismology, for the period January–June 1953, has recently been received It is published by the Dominion Observatory, Ottawa, and edited by W. E. T Smith, who regularly searches seventy-one listed publications This number of the bibliography contains 188 items from all parts of the world, including the following items No. 8163, "Deep Seismic Sounding in the Earth's Crust", G A. Gamburtsen (*Akad Nauk S S S R Vestnik*, No 4, 113, 1952); No. 8168, "Predicting the Sites of Earthquakes from Seismic and Geologic Data", I E Gubin (*Priroda*, No 4, 55, 1952), No. 8257, "Results of Seismic Observations in Germany on the Heligoland Explosion of April 18, 1947", H Reich, O Förtsch and G. A Schulze (*J Geophys Research*, 56, No 2, 147, 1951)

Institute of Personnel Management: Annual Report for 1953–54

THE annual report for 1953–54 of the Council of the Institute of Personnel Management (pp 19, from the Institute, London), presented at the annual meeting on October 9, 1954, notes the continued emphasis on the reduction of costs and the success of efforts to stimulate interest in method study and work measurement It claims that the most significant development has been the growth of an open-minded approach towards management practices, a willingness to analyse existing systems and procedures in the light of basic aims and principles, and a realization that no existing state of efficiency is incapable of further improvement Much attention has been given to the relation between personnel management and the needs of industry and commerce, and special efforts have been made to develop the Information Service The decision to introduce an external examination scheme as a means of qualification for membership marks the culmination of many steps taken over the years to realize an important object of the Institute While the Institute itself has been unable to undertake research, it has contributed to several research projects and has been represented on the steering committees discussing three research projects being planned by the British Institute of Management—on absenteeism, the cost of labour turnover, and financial information for employees

Medical Research Council Travelling Fellowships

APPLICATIONS are invited for Medical Research Council Travelling Fellowships for the academic year 1955–56 The Rockefeller Fellowships are intended for graduates resident in Great Britain who have had some training in research work in clinical medicine or surgery, or in some other branch of medical science, and who are likely to profit by a period of work at a centre in the United States or elsewhere abroad, before taking up positions for higher teaching or research in the United Kingdom The Fellowships will normally carry a maintenance allowance at the rate of 2,700 dollars a year for a single Fellow and 3,900 dollars for a married Fellow. Provision will also be made for travelling and other approved expenses The Dorothy Temple Cross Research Fellowships in Tuberculosis are intended to give special opportunities for study or research to suitably qualified British subjects of either sex "intending to devote themselves to the advancement by teaching or research of curative or preventive treatment of tuberculosis in all or any of its forms" The Fellowships will, as a rule, be awarded to candidates who wish to make their studies or inquiries elsewhere than in the United Kingdom They provide for the payment of a maintenance allowance at the rate of £650 a year for a single Fellow and £900 for a married Fellow, in addition, an allowance will be made for travelling and other approved expenses Further particulars can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, S W 1, with whom applications must be lodged not later than March 15

Oil and Colour Chemists' Association

THE 1955 Conference of the Oil and Colour Chemists' Association will be held at Llandudno during June 7–11. Most members will be accommodated at the Grand Hotel, where the technical sessions, under the general title "Film Structure and Adhesion", will be held

The seventh Technical Exhibition of the Association will be held during March 15–17 at the Royal Horticultural Society's Old Hall, Vincent Square, London, S W 1. Further information can be obtained from the General Secretary, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E C.4.

The British Instrument Industries' Exhibition, 1955

THE third British Instrument Industries' Exhibition will be held at Earls Court, London, during June 28–July 9 Concurrently with this Exhibition, there is the tenth International Printing Machinery and Allied Trades' Exhibition at Olympia, and in view of the rapidly growing importance of instrumentation to the printing industry, visitors to this will have the advantage of studying both modern printing machinery and the appropriate field of instrumentation, including temperature control

University of Birmingham

DR T L. IBBS has been awarded the personal title of professor and has been appointed to administer the Department of Physics from January 1, 1955, to September 30, 1956, in order to release Prof P. B. Moon for duties in connexion with the research programme of the department

A grant of £2,000 a year for three years has been accepted from the Aero Research Company for fundamental work on fluorine compounds in the Department of Chemistry

The title of University Research Fellow has been conferred upon Dr C A. Diaz Floris during the tenure of his present post in the Department of Chemical Engineering

Announcements

WE regret to announce the death on January 30 of Sir Edward Mellanby, lately secretary of the Medical Research Council, aged seventy.

DR. R A. LYTTLETON, of St John's College, Cambridge, has been awarded the Hopkins Prize of the Cambridge Philosophical Society for his work on comets and on the stability of rotating liquid masses. The Prize, which is of value £90, has been awarded every three years since 1867 for work in mathematical-physical or related fields The last recipient was the late Sir John Lennard-Jones

SIR CHARLES DODDS, Courtauld professor of biochemistry in the University of London and director of the Courtauld Institute of Biochemistry at the Middlesex Hospital, has been appointed a member of the Advisory Council for Scientific and Industrial Research, to fill the vacancy caused by the retirement of the late Sir Wallace Akers in September 1954

PROF. S. DEVONS, professor of physics in the Imperial College of Science and Technology, London, since 1950 (see *Nature*, **164**, 1033, 1949), has been appointed Langworthy professor of physics and director of the Physical Laboratories, University of Manchester He thus succeeds Prof P. M S Blackett, who accepted a chair in the Imperial College in 1953

DR H M STANLEY has been appointed controller of research and development of the Distillers Co , Ltd , in succession to Dr F Roffey, who remains technical director of the Company and has taken on the additional duties of personnel director of the Company's Industrial Group

TRINITY COLLEGE, Cambridge, is offering Entrance Exhibitions to students of universities in the British Commonwealth These are confined to those who propose reading for a B A. (honours), LL B. degree or a diploma. The awards are not intended for research students Each Exhibition is of the titular value of £40 a year The College is also offering a Research Studentship The value will depend on the student's income from other sources , if there are no other emoluments, the Studentship will be £425 a year. Further information can be obtained from the Senior Tutor, Trinity College, Cambridge

AN International Ore-dressing Congress will be held under the auspices of the Gesellschaft Deutscher Metallhutten- und Bergleute in Goslar (Harz) during May 8–11 Further information can be obtained from W Koch, Gesellschaft Deutscher Metallhutten- und Bergleute, Clausthal-Zellerfeld 1 (Germany), Postfach 51

AN International Congress on Materials for Aircraft and Guided Missiles will be held in Paris under the auspices of the Association pour l'Encouragement à la Recherche Aéronautique during March 28–April 1. Further information can be obtained from M. P Lefranc, délégué technique, Association pour l'Encouragement à la Recherche Aéronautique, 1 rue de Courty, Paris 7.

THIS year is the fortieth anniversary of the publication by Prof Hugh Ryan, of University College, Dublin, of his first paper on flavone chemistry. Since that time the subject has been actively pursued in Dublin under the direction of Profs T. J. Nolan, J Algar and T S Wheeler To mark the anniversary, University College, Dublin, is organizing a symposium on "Recent Advances in the Chemistry of Naturally Occurring Pyrones and Related Compounds", to be held during July 12–14 The title is to be widely interpreted and includes flavones, flavanones, *iso*-flavones and coumarins The Royal Dublin Society will consider contributions to the symposium for publication in its *Proceedings* Further information can be obtained from Mrs. Eva M. Philbin, University College, Science Buildings, Upper Merrion Street, Dublin

THE NATIONAL FOOD SURVEY IN GREAT BRITAIN

THE Nutrition Society held a symposium at the Middlesex Hospital Medical School on November 20 on the National Food Survey of Great Britain. A series of six papers was presented on various aspects of the Survey.

In his opening remarks the chairman, Dr. N. C Wright, chief scientific adviser of the Ministry of Food, referred briefly to the purposes for which the Survey was started in 1940 and to the changes in objective and scope which had taken place since its commencement The Survey was not designed to provide information which would enhance scientific knowledge in its narrower sense. It was initiated, in the climate of the 30's, against a background of the poorer diets which pre-war surveys had demonstrated in certain sections of the British population, and it was planned to provide administrators with early warnings of any dietary inadequacy from war-time shortages or changes in dietary pattern—particularly among those who were thought to be most vulnerable nutritionally In this context it was assumed that the effectiveness of the war-time food policy would be most clearly reflected in the food consumption and expenditure of urban working-class households. The records of such households were published in 1951 as the first report of the National Food Survey Committee under the title "The Urban Working-Class Household Diet, 1940–49"[1] and as a supplement to the first annual report of the Committee published in 1952—"Food Expenditure by Urban Working-Class Households, 1940–49"[2]

With the termination of the Second World War and the end of the immediate post-war shortages, it became clear that if the Survey was to provide a basis for guidance on food policy which would take into account the changing circumstances of different groups of the population, its scope must be widened. Accordingly, in 1950 it was arranged that records should be obtained from a complete cross-section of the population and thus facilitate, *inter alia*, the identification of any groups the diet of which appeared to need attention

The results of the Survey for the years 1950–52 have been published in a series of annual reports of the National Food Survey Committee under the general title "Domestic Food Consumption and Expenditure"[3]. In the first paper of the symposium, W L Readman referred to the three annual reports as sources of information on technique up to 1952, and described improvements in sample design which have since been introduced. Addresses are now selected from more than a thousand polling districts in two sets of thirty parliamentary constituencies chosen to ensure correct regional representation. The time-tables of interviewers are arranged so as to allow opportunity for persistent re-calls on the more elusive housewives Evening interviewing has been introduced These efforts, combined with the discontinuance of a former practice of weighing larder stocks, have resulted in an improved response-rate 56 per cent compared with 37 per cent quoted in the 1952 report The tendency for children to be somewhat over-represented in the sample has also been reduced. Thus, with the new method children aged 0–9 form 18 9 per cent of the sample compared with 22 5 per cent in 1950. Mr Readman also discussed the use of the income of the head of the household as an indication of social class, and referred to the recent checks which have been made on social class distribution by reference to the 'juror index' He gave some information about the coefficients of variation of nutrient intake, which have been found to be greater for certain vitamins than for other nutrients and to decrease as the size of the household increases.

In the second paper, entitled "Economics, Nutrition and Family Food Budgets", J A C Brown discussed the team-work required to conduct and interpret a survey of this kind and the place of the economist in the team He suggested that the economist's task is to determine the most important influences affecting food purchases, and gave estimates of income elasticity of the demand for foods in Great Britain based on the results of the pre-war Ministry of Labour survey and the National Food Survey He also demonstrated the relationship between family composition and food expenditure, and discussed consumer saturation for different commodities and the possibility of using such information as an indication of the effects of social policies.

The third paper, by Miss D. F. Hollingsworth, dealt with the nutritional pattern of diet in Britain on the eve of derationing Using the findings of the 1936–37 Crawford and Broadley survey and of the 1952 National Food Survey, she compared the patterns of expenditure in five groups of foods—vegetables and fruit, milk and cheese, meats, fish and eggs, bread and cereals, and fats, sugar and other groceries She showed that the 1952 pattern represented an increase in the proportionate expenditure devoted to the so-called 'protective' foods which was exhibited in all social classes approximately one-third was spent on vegetables, fruit, milk and cheese, one-third on meats, fish and eggs, and one-third on bread, other cereals, fats, sugar and other groceries. She then discussed the trends for groups of foods which were not rationed in 1952, namely, milk, bread and flour, vegetables and fruit, and fish, since it seemed that these might provide some indication of possible patterns of food consumption by different types of households under conditions of complete freedom from rationing.

The next two papers were concerned with more specialized aspects of the survey results In the first, A. H J Baines and Miss Hollingsworth presented data relating to the diets of elderly women (aged fifty-five or more) living alone. Milk consumption was well maintained at a figure above the national average. There was a preference for butter over margarine, and for mutton over beef—a fact which (taken in conjunction with the consumption of potatoes and onions) appeared to indicate a partiality to stews The consumption of bread was below the national average, but tea consumption was about 50 per cent above it In the higher age groups oatmeal was preferred to other breakfast cereals. In line with accepted requirement figures, the total energy value of the diet fell as age advanced, but was always well above recommended allowances. Intakes of all the remaining nutrients were also above the recommended levels, except for iron, which (if present requirement figures are accepted) was just marginal In the second of the two more specialized papers, Mrs. E H. Gibson, W. L Readman and

Miss G. M Warnock discussed food and family size. An analysis of the effect of children on food expenditure had already been published in the 1952 report of the Survey in the paper presented at the symposium, this analysis was extended to cover food consumption Moreover, by means of regression estimates it was also found possible to arrive at 'notional' figures for the food consumption and nutrient values of the diets of adults and children respectively, and to apply these to families containing varying numbers of children

In the concluding paper, Dr. I Leitch, director of the Commonwealth Bureau of Animal Nutrition, reviewed the day's proceedings and made comparisons between the findings of the pre-war Carnegie survey (the welcome publication of which she announced to be imminent) and those of the National Food Survey She suggested a number of points in the preceding papers which required further examination, mentioning as examples the extent of wastage of food in households of different composition and the influence of the occupation of the male earner on their consumption patterns She stressed the need for further economic analyses of the results of the National Food Survey and emphasized its great potential value.

The symposium included two sessions for discussion The first covered a wide range of subjects which related chiefly to technique Points were made on methods of assessing social class, the intelligence-levels of informants who did and did not co-operate in the Survey, the degree of variance in the results, the contribution of school meals, the pattern of family shopping and the distribution of food within the family. The second included more detailed questions relating to the later papers, for example, the extent to which domestic pets might account for the excess of intake over requirements in the homes of elderly women, and the extent to which the pre-war Carnegie survey results might be directly compared with those of the National Food Survey

The symposium was thus not only of value in giving members of the Nutrition Society a fuller picture of the National Food Survey than can be gleaned from the published reports. It equally provided those responsible for the detailed work of the Survey with an opportunity of viewing the results against a wider background and of benefiting from the lively discussion and constructive criticisms of an interested and informed audience.

---

[1] Ministry of Food, "The Urban Working-Class Household Diet, 1940 to 1949" (London H M S O , 1951)

[2] Ministry of Food, "Domestic Food Consumption and Expenditure, 1950, with a supplement on Food Expenditure by Urban Working-Class Households, 1940–1949" (London H M S O , 1952)

[3] Ministry of Food, "Domestic Food Consumption and Expenditure, 1951 (London H M S O , 1953) Ministry of Food, "Domestic Food Consumption and Expenditure, 1952" (London H M S O , 1954)

GEOPHYSICAL ASPECTS OF SOLAR FLARES

In recent years the study of solar flares has become of interest to geophysicists and astronomers alike To the geophysicist, the subject is of interest chiefly because of the direct information it can provide concerning the study of solar–terrestrial relationships. It was this particular aspect which formed the subject of the Geophysical Discussion held at the Royal Astronomical Society on November 26, at which the chair was taken by Prof V. C A Ferraro.

Carrington's classical observation of a flare was made on September 1, 1859 But solar flares are seldom seen in the integrated light of the sun, and it was not until methods had been devised many years later for observing the sun's surface in monochromatic light that a systematic study of solar flares was made possible Since then much information has been obtained, and the Geophysical Discussion dealt principally with the geomagnetic, ionospheric and radio influences of solar flares.

Mr H W. Newton (Royal Greenwich Observatory) described by means of slides the chief characteristics of solar flares so far observed. Their basic association with sunspots, their sudden appearance and short life relative to sunspots, their great extent for those of first magnitude, and certain repetitive features are of significance in studying their geophysical effects In particular, the distinctive development curve of typical flares with its high and brief peak (flash of radiation) should be noted

Two types of effects are recognizable (1) from solar electromagnetic radiation, producing effects on the day hemisphere , and (2) from solar particles affecting both day and night hemisphere The former include the geomagnetic crochet, the short-wave radio fade-out, the long-wave improved transmission and solar 'noise' A number of crochets synchronous with great flares have been used in conjunction with the observed maximum of the visible light ($H\alpha$ usually) to give a time-interval (effective time of travel from sun to earth) to the 'sudden commencement' of the ensuing geomagnetic storm. A histogram, of 5-hourly intervals over the 72 hr following the crochet, shows a distinct peak at the interval 17–21 hr The average from all the data was nearly 30 hr , the most active storms giving a significantly shorter interval of 22 hr These results, Mr Newton concluded, confirm and extend the purely statistical relationship between the greater sunspots and the greater geomagnetic storms , but flare occurrence does not explain a large proportion of the smaller storms, namely, those with indefinite onset and a tendency to recur at intervals of twenty-seven days. For these storms, the corona has to be invoked, but results so far lack coherence

Mr J S. Hey (Radar Research Establishment, Ministry of Supply, Malvern) described an analysis of the distribution across the solar disk of solar flares with associated radio bursts at $\lambda = 4\ 1$ m In an analysis of observations during part of 1946–47, it was noticed that radio bursts occurred more frequently in association with flares on the eastern half of the solar disk than on the western half, and it was tentatively suggested that the asymmetry might be due to absorption in solar corpuscular streams

Subsequent observations of radio bursts up to 1951 have confirmed the radio asymmetry If the supposition that the asymmetry is caused by absorption in corpuscular streams is correct, it seems probable that a correlation should exist between the distribution of radio bursts and high geomagnetic activity, which might be taken as an index of the arrival of solar particles in the earth's atmosphere.

Recent analysis has indicated that the active solar regions which produce high geomagnetic character figures also have high radio-burst activity , and if the progress of these regions is followed as they cross the solar disk, it is found that the radio-burst activity is a maximum to the east, falls toward central meridian, and rises again slightly on the west However, as the anomalous distribution of radio-burst activity tends to occur for all values of magnetic activity, the absorption is not restricted to regions from which corpuscular streams have sufficient velocity to reach the earth.

The question then arose as to whether the asymmetry in the distribution of visual solar flares might be caused by optical absorption, since it is feasible that both radio and optical absorption effects could occur Analysis of distribution of solar flares observed in Hα during the years 1947–50 showed that the asymmetry was more marked when those flares occurring within a few days of high geomagnetic activity were selected The results strongly suggest that the asymmetry both in the distribution of flares and in radio-bursts associated with flares is an absorption effect, which is emphasized by the selection of observations in close relation to high geomagnetic activity.

Dr M A Ellison (Royal Observatory, Edinburgh) dealt with the flash of ultra-violet radiation generated by a flare giving rise to sudden disturbances in the terrestrial ionosphere, known collectively as S I.D.'s These disturbances are confined to the illuminated hemisphere of the earth and may be recorded in a variety of ways We do not yet know what wave-lengths are involved. We speak of the S I D 's as the 'simultaneous effects' of flares But, in fact, accurate timings show that they are not quite simultaneous with the flash of visible radiation, as observed in Hα light, there is a lag of some minutes between the peak of the flare and the maximum of the ionization which results from it

The extra ionization caused by a flare is believed to be confined to the D-layer, in the level 60–90 km., and the study of the various time-delays yields valuable information about the processes which occur in this region

The S I D 's are recorded in the following ways (1) crochets in terrestrial magnetism (conductivity effect), (2) short-wave radio fade-outs (S W F) 5–15 Mc/s and cosmic noise fade-outs (S C A) 18 Mc/s (absorption effects), (3) sudden phase anomalies (S P A) of very long radio waves 16 kc./s (lowering of D-layer reflecting ceiling), (4) sudden enhancements of atmospherics (S E A) 27 kc/s (improved reflectivity of D-layer at oblique incidence), (5) sudden anomalies in the field-strength (S F A) of a distant 16-kc/s transmitter (interference between ground-wave and sky-wave from D-layer)

At Edinburgh the development curves of the S.I D 's have been compared with those of the flares which generate them The development curve of a flare consists of a plot of Hα line-width, or of central intensity, versus time Either method yields the same values for the times of beginning, maximum and end of the flare The results for the time-delays are as follows

	S I D. max –flare max	No of cases
(1) Crochets	2 5 min	13
(3) S P A	5	8
(4) S E A	7	21
(5) S F A	5	8

The standard error in each case is of the order of 1 min In addition, it was found that after an intense flare (Class 3 or 3+) the ionization in the D-region does not return to the pre-flare value for a period of the order of 1 hr after all visible radiation has ceased

It is natural to suppose that the intensities of the visible and ultra-violet wave-lengths in the flare radiation follow the same course of rise and decay with time, even though only the former can be directly observed It was therefore assumed that the observed time-delays are to be interpreted as 'relaxation times', due to the sluggishness in the response of the D-layer to the increase in ionizing radiation

It follows from this that the number of free electrons at this height increases during a flare by five to ten times the normal value This result is in good agreement with the value derived by Appleton and Piggott from the increase of absorption which is observed during a short-wave fade-out

The relatively small time-delay for the maximum of the crochet is a most significant feature, it appears to indicate that the crochet currents do not flow at the same level (70–75 km.) as that in which the sudden enhancement of atmospherics and sudden phase anomalies effects originate. It is now generally believed that the S_q currents, responsible for the magnetic daily variation, flow at a height of 100–120 km. The crochet currents are in the same sense as the S_q currents flowing at the time and appear as an enhancement of these currents But this does not necessarily mean that both are located at the same level. Referring to his 1950 paper, Dr. Ellison remarked upon the following facts (1) Crochets are associated with intense flares (Class 3+ and 3, and only rarely with Class 2 flares). (2) The radiation from lesser flares (Class 1 and most Class 2) is known to produce ionization at heights of 70–75 km, as shown by the associated sudden enhancement of atmospherics and sudden phase anomalies. This radiation must have traversed the E-layer, yet it produces no increase in conductivity (that is, no crochet is observed) (3) The crochet only occurs during deep ionization of the D-layer, that is, when the 15-kc/s reflecting ceiling for sudden phase anomalies falls from 75 km to about 65 km. or lower. (4) Only the more intense fade-outs (about one in three) are accompanied by crochets (5) The duration of the crochet is much less than the duration of the ionization in the 70–90 km level, as recorded during the same flare by radio methods This indicates a higher recombination coefficient, that is, lower level

For these reasons Dr Ellison concluded that the crochet currents must be the result of an increase in conductivity at a low level of about 60–70 km

Again, the crochet currents associated with an intense flare are such as to indicate an increase in conductivity by a factor of less than 2, if we assume that they are caused by simple enhancements of the existing S_q currents. On the other hand, the fade-out absorption during a flare shows that the electron population in the absorbing layer (70–90 km) undergoes an increase of five to ten times. This fact, together with the short time-delay for crochets and the absence of crochets in association with lesser flares, suggests that the 70–90 km level does not make an appreciable contribution to the crochet current-system

The evidence, therefore, points to the formation of crochets through the establishment of an independent current system in the base of the D-layer, the ionization at this level (~ 60 km) being enhanced only during an intense flare

Dr K Weekes (Cavendish Laboratory, Cambridge) next discussed the ionization produced in the ionosphere during a solar flare From observations of the changes of height of reflexion and absorption of waves of radio-frequency near 2 Mc./s. and from the sudden phase anomalies observed with very long radio waves, Dr. Weekes stated that it is possible to make deductions about the distribution with height of the ionization produced during the solar flare. These lead to the conclusion that the greater part of the extra ionization is produced in the lower E-region between 95 and 100 km. The increased absorption appears to be due to a more or less independent production of ionization near 70 km. which also gives rise to the effects observed with very long waves.

The variation of the various phenomena with time allows tentative deductions about the ionizing radiation and about various parameters in the ionosphere.

Finally, Dr. H. Elliott (Imperial College of Science and Technology, London) discussed the increases of cosmic rays observed during intense solar flares. He first remarked that during the past seventeen years there have been four occasions on which increases in cosmic ray intensity have been observed at a number of widely separated stations at the time of an intense solar flare. The magnitude of the increase depends on latitude, local time and height above sea-level. On none of these occasions was any increase observed at Huanayo near the geomagnetic equator, and this leads to the conclusion that the primary particles responsible for the increase are charged and have a maximum energy rather less than 10^{10} eV. In addition to these large increases, which have amounted in some cases to more than 100 per cent, it has now been established that smaller increases of the order of 1 per cent occur at the time of less intense flares. Assuming that the primary particles come from the sun, the impact zones on the earth can be calculated by taking into account the deflexion in the earth's magnetic field. Firor has shown that there is rough agreement between the observed and calculated intensity distribution over the earth, which indicates that the particles come from a region on or near the sun.

In the short discussion that followed, Prof. Ferraro directed attention to the interest for the theorist of Dr. Ellison's conclusion that the crochet currents flow at a level of about 60–70 km. For the question now arises as to whether one can account for the electromotive force needed to drive the crochet currents. Attention was also directed to the fact that no corpuscular radiation associated with solar flares other than that with speeds of about 10^8 cm./s. and 10^{10} cm./s. has so far been detected. We must await further developments to see whether this is, in fact, the case, or whether there is a continuous velocity spectrum in the corpuscular radiation ranging from about 10^8 cm./s. to 10^{10} cm./s.

V. C. A. FERRARO

FIELD-EMISSION AND SURFACE PHENOMENA

SYMPOSIUM AT PITTSBURG

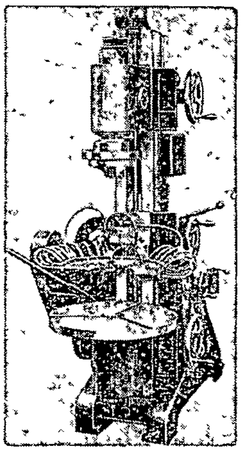
A SYMPOSIUM dealing with field-emission and surface phenomena was held at the Mellon Institute, Pittsburg, Pa., during November 10–12, and was attended by about eighty members. A banquet was held at the University Club, at which the guest speaker was Dr. W. E. Schoupp, director of development, Westinghouse Atomic Power Division, who spoke on power sources of the future. Dr. M. M. Wachtel (Westinghouse) was chairman of the Symposium Committee responsible for the excellent conference arrangements.

The first session, devoted to field-emission and electrical breakdown, was opened by a paper by F. Llewellyn Jones (Swansea, Wales) on problems of the cold liberation of electrons and discharge initiation. With fields ∼ 10^5 V./cm., two liberation mechanisms are found. One is dependent upon the presence of sites, for example, negative ions of water molecules, from which detachment occurs under the electric field; the removal of water vapour practically eliminates the emission. The other mechanism arises after the passage of a discharge, and apparently involves cold emission in a field enhanced by positive ions at a cathode tarnish layer; the role of such films was discussed. E. W. Mueller (Pennsylvania State) discussed emission due to momentary stripping of adsorption layers of barium, thorium and sodium with high electric fields up to 375 MV./cm. (field desorption). The field is sharply defined for any given adsorbate and depends on the crystallographic structure of the substrate. Auto-ionization can occur before the molecules touch the metal, and continuous field ion emission is made possible by surface migration to the emitting area. Application to mass-spectrometry was indicated. L. H. Germer (Bell Laboratories) discussed the role of field-emission for the extreme cases of breakdown under very high gas pressure and also *in vacuo*. For the former, the mechanism proposed is the field-emission of electrons following the Fowler–Nordheim equation in a field enhanced by the presence of positive ions near the cathode, the effective increase in the secondary coefficient γ thus corresponding to a lower sparking potential in the breakdown criterion. For vacuum breakdown, vaporization of the anode is suggested with ionization of the vapour atoms, the resulting positive ions enhancing the field of the cathode to produce field-emission. Experiments on a formative time-delay of high-vacuum sparks were described by H. G. Heard (California) using a pulse which rose in $6 \cdot 6 \times 10^{-10}$ sec. and of duration ∼ 5×10^{-9} sec. It was found that initiation of a vacuum spark depends on two effects: a current precursor, and its subsequent rise. The measured delays cannot be reconciled with any clumping or cathode heating mechanisms.

The next session dealt with electron and ion sources. The production of high-energy electron beams was described by L. Marton and R. A. Schrack (National Bureau of Standards). Field-emission offers an attractive source for certain electron optical applications, for high brightness and small virtual areas make field-emitters more effective than thermionic sources when spots less than 0·3 micron are desired. Application to small X-ray sources, electron-probe micro-analysis, and to the determination of composition and orientation in the micro-crystalline structure of metals was described. A paper entitled "Can One Observe Individual Atoms and Molecules in the Field Emission Microscope?" was read by J. A. Becker (Bell Laboratories). The discussion was concerned with the origin of very bright spots on the screen of a field-emission microscope, from the behaviour of which it is concluded that they originate in individual atoms or molecules adsorbed in a special state. M. G. Inghram and R. Gomer (Chicago) described a mass spectrographic analysis of the ions formed in hydrogen (and other gases) in the Muller field-ion microscope, the peak width for mono-energetic 10,000-V. ions was 20 V.,

Glass Working Lathes

The Universal model illustrated may be used either horizontally or vertically.



Heathway glass working lathes are the most widely used in Britain

There are five models to choose from. May we send you leaflets ?

Heathway
Machinery Co. Ltd.
UXBRIDGE ROAD, HILLINGDON, MIDDLESEX.
PHONE UXBRIDGE 6345 GRAMS HECO.

Variational Principles in Dynamics and Quantum Theory

By WOLFGANG YOURGRAU, Dr Phil
and STANLEY MANDELSTAM,
B Sc (Eng), B Sc (Rand)

In this book, the authors deal with the mathematical foundations of Variational Principles and those sections of dynamics (such as the Hamilton-Jacobi theory) to which they are related The principle of least action is analysed also from a historical viewpoint, while an evaluation is attempted of the conflicting philosophical conclusions which eminent scientists have reached on this subject Allied topics discussed include an examination of the role of Variational Principles in the development of quantum mechanics, as well as the application of Hamiltonian methods to electrodynamics 25/- net

PITMAN
Parker Street, Kingsway, London, W.C 2

McGRAW-HILL • LONDON

Introduction to Theoretical Mechanics

This text for physics graduate students provides a sound introduction to classical mechanics Emphasizing the solution of problems, the author aims to train the student to approach difficult problems in a confident and successful manner, and to accustom him to the procedures of physical reasoning The number of topics has been limited so that none is superficially treated Newtonian mechanics is emphasized in all but the last three chapters as the author feels that this aspect of the subject must be thoroughly mastered before the student is introduced to the short-cuts provided by the more generalized co-ordinate methods The latter procedures are treated in the last three chapters

The three-dimensional motion of rigid bodies is covered, and several applications to astronomy and atomic physics are presented in the form of problems Other topics not usually treated in a book of this nature include · non-linear vibrations , the motion of a body the mass of which varies (a rocket), generalized co-ordinates , vibrating systems of several degrees of freedom , a vibrating system having a large number of degrees of freedom—the vibrating string—treated both from the normal co-ordinate point of view and from the standpoint of travelling waves Worked-out examples and chapter-end problems are included

9 × 6 inches 500 pages 57s 6d

By ROBERT A. BECKER
Associate Professor of Physics,
University of Illinois

Obtainable shortly from your Bookseller

New and forthcoming books

The Nitrogen Metabolism of Micro-Organisms

B A FRY

Lecturer in Microbiology, University of Sheffield

(Monographs on Biochemical Subjects)

This monograph provides a convenient introduction to one important section of microbial biochemistry The underlying theme is none other than that known to all biologists as the 'Nitrogen Cycle,' and an attempt has been made to analyse some of the component steps of the cycle from the standpoint of the biochemistry of the various reactions and the micro-organisms concerned

With 3 plates and 15 diagrams *9s 6d*

Photosynthesis

ROBERT HILL, F R S , and
C P WHITTINGHAM, Ph D

(Monographs on Biochemical Subjects)

A concise but comprehensive survey of current research in Photosynthesis, dealing first with the earlier classical work on the physiology of photosynthesis and then discussing the relevant basic biochemical aspects of the subject

With 20 diagrams *8s 6d*

Qualitative Inorganic Analysis

G CHARLOT

Professor of Chemistry at L'École Supérieure de Physique et Chimie, Paris

Translated by R C. MURRAY, Ph D , B Sc

"There is a definite place for this book in the literature of analytical chemistry It provides a very well written and thorough physico-chemical approach to qualitative analysis " *Chemical Age*

With 93 diagrams *42s*

Now reprinted

Protons and Electrons

K H SPRING, M Sc

(Monographs on Physical Subjects)

With 38 diagrams *7s. 6d.*

METHUEN

The SCIENTIFIC BOOK SUPPLY SERVICE

(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

THE MICROSCOPE

A bi-monthly journal of microscopy & photomicrography

JAN /FEB ISSUE PUBLISHED SHORTLY

A copy gladly sent for your inspection when ready

THE MICROSCOPE, 4 New Zealand Ave., London, E.C.1

Subscription 15s per annum

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE

FROM LIVER OR YEAST

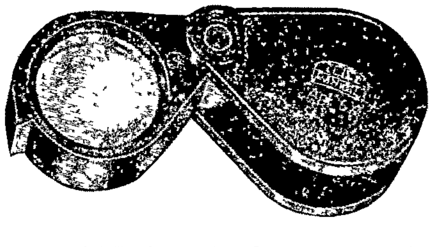
and other SIGMA brand products are now available
Ask for list SIGMA 8

GEORGE T. GURR LTD.

136-138 NEW KINGS RD, LONDON, S W 6

The Microscopical Stain People

ZEISS
WINKEL



ZEISS LOUPES

These world-famous magnifiers which set the standard many years ago are now being manufactured in their Winkel factory. They are achromatic and aplanatic, mounted in black folding plastic covers, and they are available singly in magnifications of 6×, 8×, and 10×, at £2 10s each, and in the double folding form 3× and 6× which used together give 9× at £4 7s 6d each

RAYNER

100 NEW BOND STREET, LONDON, W 1

Telephone GRO 5081

MACMILLAN BOOKS

Science and its Background

H D ANTHONY, M A (Cantab), B Sc, Ph D (Lond), F R A S.

Here is the story of science, with the background of history in which that story is set Although most of the chapters centre around individual men of science whose work is of value to-day, the historical background is not only that of isolated biography but the continuous history of human affairs Two chapters, on post-war developments and the pursuit of science for its own sake, have been added for this second edition. *Second Edition* 20*s*

A Text-book of Electricity and Magnetism

G R. NOAKES, M A, F Inst P

This is the new, Third Edition of a book which will meet the need of those taking Intermediate degree courses and the Advanced and Scholarship Examinations of the General Certificate of Education All the usual topics required at this stage are dealt with, and where necessary calculus is used Among the special topics discussed are the conduction of electricity through gases, atomic physics and modern views on ferro- and terrestrial magnetism *Third Edition* 14*s*

Advanced Level Examples in Physics

R V JOHNS, M A, B Sc

Lecturer in Physics and Mathematics, City of Liverpool College of Technology

W. F. WARE, B Sc, A.Inst P

Senior Physics Master, Cathays High School for Boys, Cardiff

This book of numerical examples is designed to supplement the theoretical and laboratory work of students preparing for examinations in Physics at the Advanced level of the General Certificate of Education and for Intermediate Degree examinations Some 1,000 examples have been arranged by topics and carefully graded in difficulty Contents are arranged under the headings Mechanics and Properties of Matter, Heat, Light, Sound, and Magnetism and Electricity 16*s*

Comprehensive Inorganic Chemistry

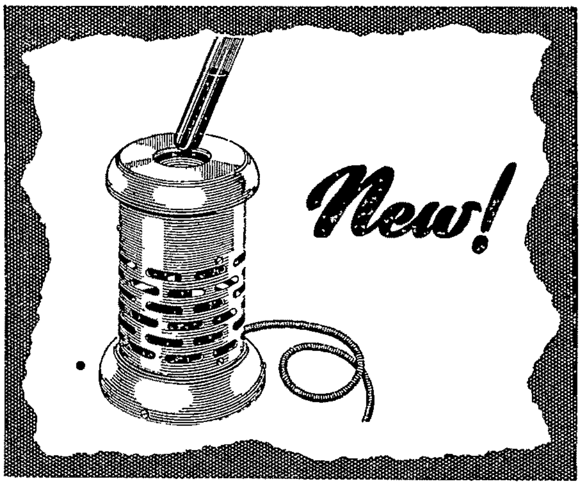
Edited by M CANNON SNEED, J LEWIS MAYNARD and ROBERT C BRASTED

Volume III—The Halogens, by ROBERT C BRASTED

Comprehensive Inorganic Chemistry is an eleven-volume reference work on the chemical elements and their inorganic compounds In this Third Volume the significant advances of recent years are fully reflected in a broad treatment of halogen chemistry Both basic principles and their applications are exhaustively covered, as well as the new processes, methods of production, and the chemistry of compounds which have lately become so important 35*s*.

All prices are net

St. Martin's Street, London, W.C.2



ELECTROTHERMAL "BUNSEN"

(Pat pdg Regd Design 875,606)

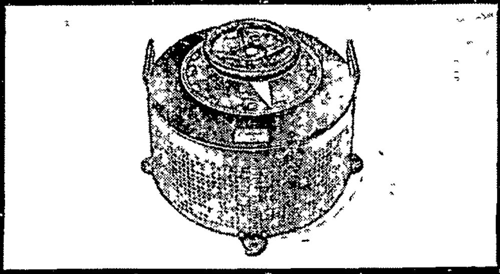
An indispensable apparatus for use in laboratories for heating test-tubes, crucibles, etc Available from all Laboratory Supply houses Write for leaflet now

Safe, efficient and economical in use. Guaranteed for 12 months.

Electrothermal Engineering Ltd.

270 NEVILLE ROAD, LONDON, E.7 Telephone GRAngewood 005

VARIACS for S-M-O-O-T-H Voltage Control



The "VARIAC"† is the original, continuously adjustable auto-transformer . . . the ideal control for varying the a-c voltage applied to any electrical, electronic, radar or communications equipment.

Voltages from Zero to 17% above line are obtained by a 320-degree rotation of the shaft, which is equipped with a direct-reading dial, calibrated accurately.

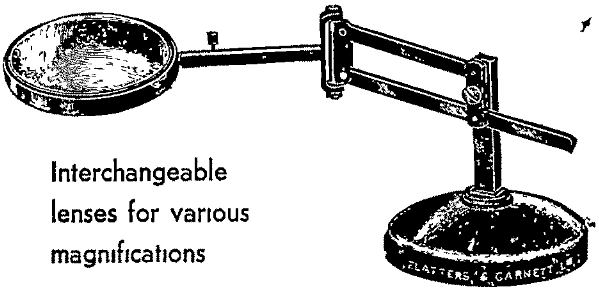
"VARIAC" offers many real advantages over any other type of a-c control: compared with the losses of resistive controls they save their initial cost within about one year. They are available in various sizes from 170 VA up to 25 Kilowatts, 3-gang assemblies are also available for 3-phase working. Prices vary from £7.10.0. upwards.

Write for our Catalogue—Technical Manual V-549, which gives all possible information, to:

CLAUDE LYONS LTD.

Electrical and Radio Laboratory Apparatus, etc
Head Office and Works **76, Oldhall Street, Liverpool 3, Lancs**
Southern Factory **Valley Works, Ware Road, Hoddesdon, Herts (A10 main London/Cambridge Rd, Junction A602)**

PARALLEL LENS STAND



Interchangeable lenses for various magnifications

Lens always remains parallel with bench

With 4" diam lens as illustrated £3.11.6. each

1 doz or more £3 7 6 each

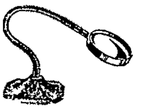
Delivery from stock

FLATTERS & GARNETT LTD.

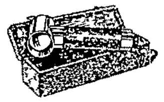
Microscopists and Scientific Instrument Makers

309 Oxford Road, Manchester 13

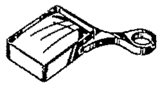
Over 50 Years' Service to Microscopy



"QUICKSET" MAGNIFIER



"RESEARCH" Illuminated Magnifier



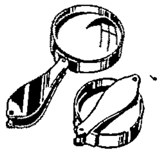
RECTANGULAR READERS

"ENBEECO"

MAGNIFIERS

"EASYSET" MAGNIFIER

There is an "Enbeeco" magnifier to meet every conceivable need of industry, science, education and recreation. Patterns include pocket, hand and stand models—folding or non-folding, stand, adjustable stand, illuminating or non-illuminating. Just send us details of your requirements and leave the rest to "Enbeeco"



FOLDING READERS

36 PAGE MAGNIFIER CATALOGUE
Fully illustrated, sent FREE on request

NEWBOLD & BULFORD LTD
ESTABLISHED 1796
Manufacturers and Exporters of Optical and Scientific Instruments and Ophthalmic Supplies etc
"ENBEECO" HOUSE, ROGER ST. GRAYS INN RD., W.C.1.
TELEPHONE CHANCERY [illegible] (3 LINES) TELEGRAMS BULFORD, PHONE LONDON

MANUFACTURERS "Enbeeco" PRODUCTS
DISTRIBUTORS LEECH PRODUCTS

Complete in 2 volumes

The Nucleic Acids

CHEMISTRY AND BIOLOGY

Edited by **ERWIN CHARGAFF and J. N. DAVIDSON**

This new and modern treatise, organized systematically, will appeal equally to advanced students and investigators. Every effort has been exerted to include existing data in lucid and concise fashion, and to appraise objectively current trends of research Both volumes contain numerous working directions on preparatory and analytical methods.

Volume I, February 1955

692 *pp*, *illus*, 120*s*.

J N. Davidson and Erwin Chargaff, Introduction
W G `Overend and M. Stacey, Chemistry of Ribose and Deoxyribose
Aaron Bendich, Chemistry of Purines and Pyrimidines
J. Baddiley, Chemistry of Nucleosides and Nucleotides
Hubert S Loring, Hydrolysis of Nucleic Acids and Procedures for the Direct Estimation of Purine and Pyrimidine Fractions by Absorption Spectrophotometry
Waldo E Cohn, The Separation of Nucleic Acid Derivatives by Chromatography on Ion-Exchange Columns
G R. Wyatt, Separation of Nucleic Acid Components by Chromatography on Filter Paper
J. D Smith, The Electrophoretic Separation of Nucleic Acid Components
Zacharias-Dische, Color Reactions of Nucleic Acid Components
Erwin Chargaff, Isolation and Composition of the Deoxypentose Nucleic Acids and of the Corresponding Nucleoproteins
Boris Magasanik, Isolation and Composition of the Pentose Nucleic Acids and of the Corresponding Nucleoproteins
D. M Brown and A. R Todd, Evidence on the Nature of the Chemical Bonds in Nucleic Acids
D O. Jordan, The Physical Properties of Nucleic Acids
G. H Beaven, E. R Holiday and E A Johnson, Optical Properties of Nucleic Acids and Their Components
G Schmidt, Nucleases and Enzymes Attacking Nucleic Acid Components
Author Index—Subject Index

Volume II, March 1955

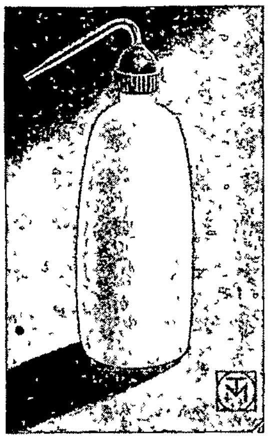
Contributors. J. Brachet, G. B Brown, A. L Dounce, Gertrude E. Glock, G. H. Hogeboom, R. D. Hotchkiss, I Leslie, P. Reichard, P. M. Roll, F. Schlenk, W. Schneider, R M S. Smellie, H. H. Swift, B. Thorell, R Vendrely.

Descriptive leaflet available upon request

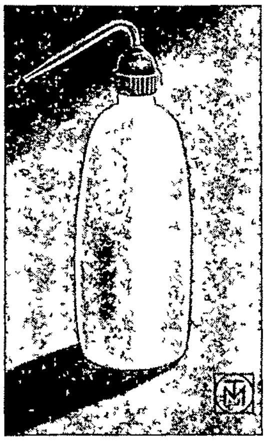
Academic Press Inc., Publishers
125 East 23 Street, New York 10, N.Y., U.S.A.
British Office: ACADEMIC BOOKS LTD.,
129 Queensway, London, W.2

THE POLYTHENE WASH BOTTLES

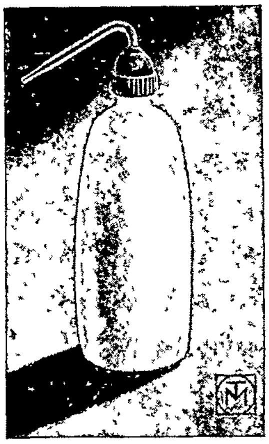
Recent Improvements



ONE—POLYTHENE STOPPERS IN PLACE OF PERBUNAN



TWO—SLIGHTLY LARGER CAPACITY—250 ml



THREE—4 DIFFERENT COLOURED TOPS

and now

FOURTHLY—A LARGER SIZE—500 ml.

With all the above improvements and interchangeable stoppers

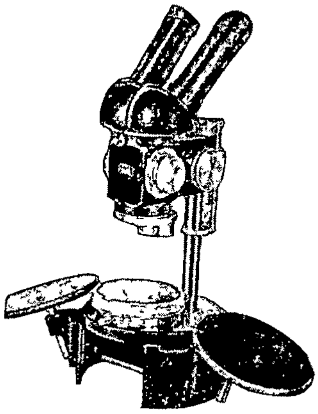
PRICES SMALL (250 ml) X 80, 3/4 each, 36/6 doz LARGE (500 ml) X 180, 5/3 each, 57/- doz

TOWNSON & MERCER LIMITED · CROYDON · ENGLAND

Telephone· THOrnton Heath 6262

CARL ZEISS

STEREO MICROSCOPE



Rapid change of magnification in five steps from ×6 to ×40, ×12 to ×80, or ×24 to ×160 simply by turning a drum The long working distance remains unchanged with change in magnification Illustrated booklet from

DEGENHARDT & CO., LTD.

32 MADDOX STREET, LONDON, W 1

Mayfair 6639

Sole importers for Gt Britain and N Ireland

Fine Quality 17-Jewel

CHRONOGRAPH

Stainless Steel Case

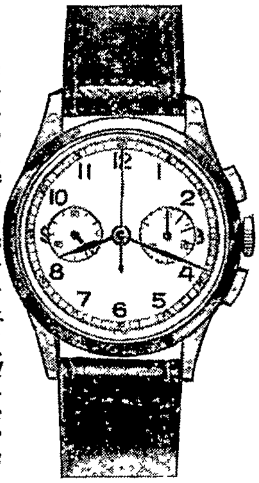
Model W C 2

Beryllium alloy, non-magnetic overcoil balance spring, temperature variation producing negligible effects Safety device to eliminate effects of shock on balance spring. The balance assembly is supported between shock-proof bearings

The entire movement embodies the latest technical improvements. **£30 5s 0d.**

Also available as Model W C 2a in stainless steel moisture-proof case **£34 0s. 0d.**

Further particulars of these and other first-quality watches, chronographs and stop watches, are given in our new catalogues, copies of which will be gladly sent on request



Guaranteed repairs Timing service Certification

CAMERER CUSS

Timing Division

Makers of Good Clocks & Watches since 1788

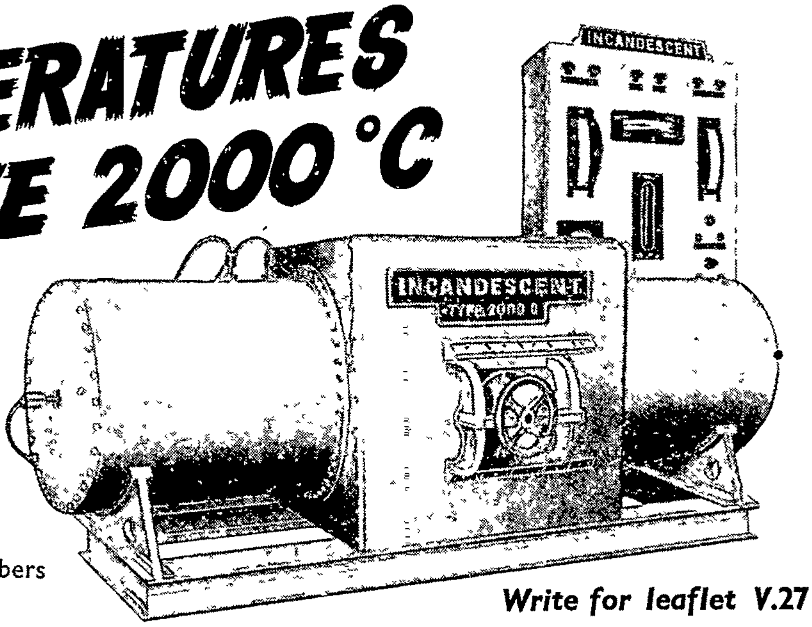
AT

NEW OXFORD STREET, LONDON, W.C.1

MUSeum 8968/9

Our only other address, 91 Kingsway, W C 2

TEMPERATURES ABOVE 2000 °C



An entirely new concept in Thermal Engineering, providing a practical tool for metallurgical and ceramic research at temperatures over 2000° C Fuels—town gas, bottle gas (Butane, Propane) or light oil.

Size of working chambers 16" × 16" × 16"

Write for leaflet V.27

THE INCANDESCENT HEAT CO. LTD.

SMETHWICK—ENGLAND

28/14A/55

★ ★ ★ ★ ★ **GRATICULES** ★ ★ ★ ★ ★

★ **PRECISION PHOTOGRAPHY** ★

★ **MEASURING SCALES** ★

★ **DIVIDED CIRCLES** ★

★ **SEGMENTS** ★

★ **ARCS** ★

★ ★

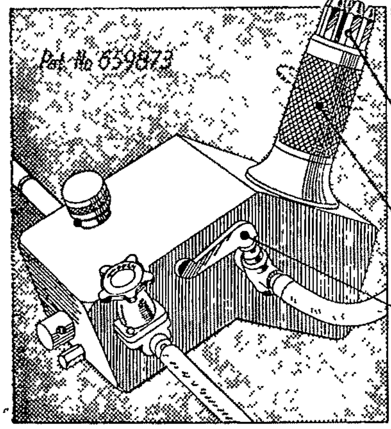
★ ★

★

Paton Hawksley

Rockhill Laboratories • Keynsham • Somerset

The Scorah OXY-COAL GAS BLOW PIPE



specially for working **BOROSILICATE GLASSES (Pyrex, Phoenix, Hysil, etc)**

- Five jets and central pilot light — flame size selected INSTANTANEOUSLY
- Rotating turret head for easy jet selection
- Auxiliary supply of oxy coal mixture for hand torch

Minimum oxygen consumption
Maximum economy

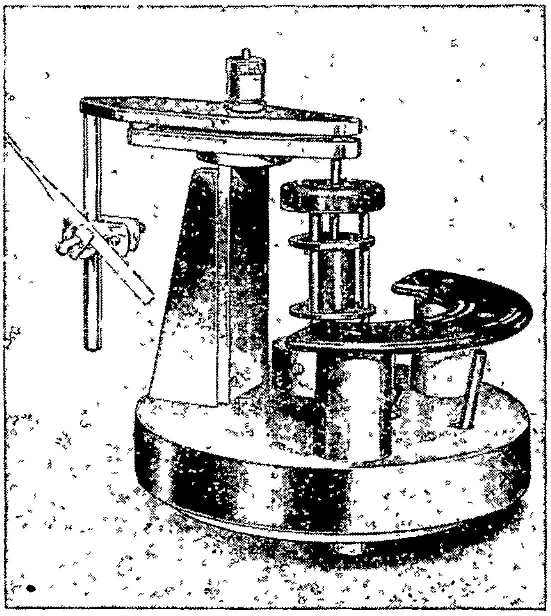
A modern oxy-coal gas blow pipe of sturdy construction evolved through years of practical experience in glass manipulation A nearly silent flame from pin point to one capable of working 100 mm tubing at a flick of the turret To the inexperienced it gives confidence, to the experienced it is an assurance of efficiency and successfully completed work A unique instrument for the research laboratory or workshop Send for Leaflet BP/N2

Obtainable only from Price **£19.10.0**

L.V.D. SCORAH M.Sc. 44, NORTHFIELD RD. BIRMINGHAM, 30
phone: KINGS NORTON 1885

SINGER MICROMANIPULATORS
(patent application 11559/43 Foreign patents pending)

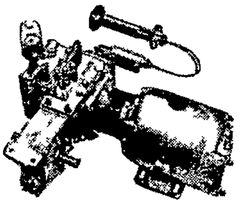
As described by Barer and Saunders-Singer, Q J M S , Vol 89, pp 439-74, Dec 1948



SINGER INSTRUMENT COMPANY LIMITED
Fountain Court, 83 London Street, Reading, Berks, England
Manufacturers also of the Singer Microdissectors

INFINITELY VARIABLE SPEED

Hydraulic Gears at less than 15% of original cost



Unit illustrated ¾ H P Brook Gryphon Motor, 5 1 Croft Worm Reduction Gear, both flange-mounted to the Transmission, which is fitted with hydraulic (remote) control (Output speed 0-174 r p m max torque 450 lb in)

Write for full details
Illustrated brochure and long list of famous users sent by return Originally made by Vickers-Detroit at over £230 Each unit transmits up to 2 B H P Zero to 1,240 r p m in either direction Six months' guarantee Units now also supplied complete with electric motors, starters, remote controls, reduction gears, etc , if required.

N. J TATHAM & CO LTD.
(Dept. 6) Lowfield Works • Haywards Heath • Sussex

WALLACE HEATON LTD

FOR MICROSCOPES

SECONDHAND BARGAINS

Beck Laboratory, 3 objectives, £48 10s , Watson "Kima," 2 objectives, £25 10s , Watson "Service," Laboratory, £47 10s , Swift Botanical, 2 objectives, £8 10s , Spencer Laboratory, 3 objectives, £42 10s , Schutz, Student type, £10, Zeiss, 3 eyepieces, 3 objectives, £33 10s , Beck 47C (2a), £45 10s , C T & S Medical, 2 objectives, £22 10s , Bausch & Lomb, Botanical, £7 10s , Beck Medical, 2 objectives, £27 10s , Watson "Service," Medical, £32 10s , Baker Laboratory, £52 10s , Beck Medical, 3 objectives, £30

Write or call for Lists EASY PAYMENTS AVAILABLE

BY APPOINTMENT TO
[illegible]
SUPPLIERS OF PHOTOGRAPHIC EQUIPMENT

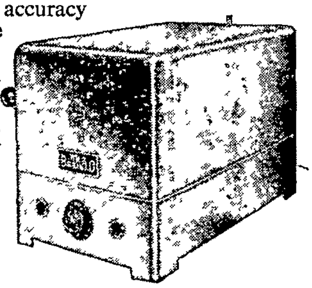
127 NEW BOND STREET, LONDON, W 1 MAYFAIR 7511

Horizontal Rectangular MUFFLES

Wild-Barfield, the largest manufacturers of laboratory muffles, produce four standard models which will meet most requirements

Precise temperature control is possible with these muffles, thus allowing laboratory processes to be undertaken with great accuracy

Operating temperature up to 1000°C The chamber sizes are from 8″ × 3″ × 3″ to 19″ × 7½″ × 5″



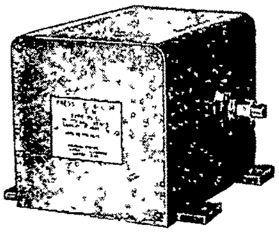
Single or twin tube and high temperature muffles are also available Full details will gladly be supplied

WILD-BARFIELD
ELECTRIC FURNACES
for all *heat-treatment purposes*

Wild-Barfield Electric Furnaces Ltd ,
23 Elecfurn Works, Watford By-Pass, Watford, Herts
Telephone Watford 6091

SENSITIVE

PRESSURE SWITCH



TYPE PV/LI

The Type PV/LI pressure/suction switch operates in the range from $\frac{1}{2}$ in to 10 in w g, and may be used with non-corrosive gases or liquids in ambient temperatures up to 120° C The instrument uses a large bellows as the pressure sensitive unit, which is coupled through suitable linkages to a heavy duty mercury switch

A catalogue describing the switch shown above and other models is available on request

DELTA TECHNICAL SERVICES LTD
FAIRFIELD ROAD KINGSTON-ON-THAMES . SURREY
TEL KINgston 9568

GLASS

All Glass Requirements for Scientific Instrument Manufacturers and Research Workers

- SHEET & PLATE-GLASS—cut and ground to exact dimensions
- LENSES, PRISMS & FLATS—to any standard of accuracy
- MIRRORS—back silvered and front surface aluminised, etc
- BLOOMING of optical components

C. J. WHILEMS, LTD.
ILFORD OPTICAL WORKS
FOREST ROAD, BARKINGSIDE, ESSEX

Telephone HAInault 2554

Colloidal

Mo S_2

The name of ACHESON COLLOIDS LIMITED has been associated, for over 50 years, with the manufacture of colloidal dispersions of graphite and other solids Now to their well-known range of 'dag' dispersions, they add colloidal dispersions of molybdenum disulphide. This outstanding new lubricant is being applied with great advantage to :—

Die forging, drawing, extrusion and cutting of metals,
Lubrication in operations involving high pressure and temperature,
Dry lubrication.

If you are interested in these new developments or in the various applications of our range of products our technical staff will gladly discuss them with you

dag
DISPERSIONS

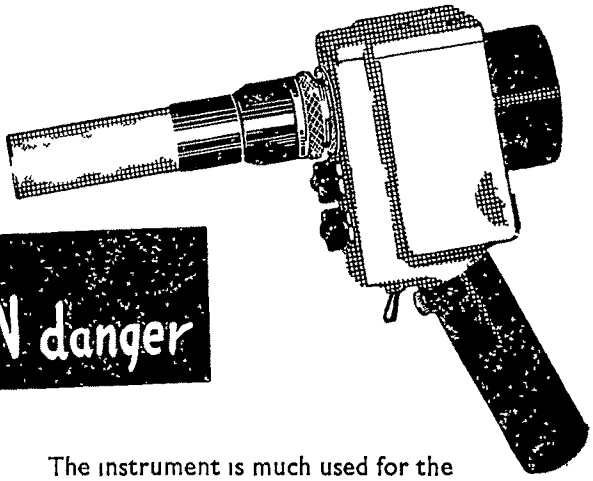
of Colloidal Graphite, Molybdenum disulphide, metallic Silver, Titanium dioxide and other substances.

ACHESON COLLOIDS LIMITED
18 PALL MALL, LONDON, S W 1
Telephone WHItehall 2034-7
Telegrams OILDAG, PICCY, LONDON
Also ACHESON COLLOIDS COMPANY
Port Huron, Michigan, U S A
Units of Acheson Industries

TAS/AC 57A

STATIC

an UNSEEN danger



The Statigun measures potential gradient in air over the range 0-300kv/ft. Attachments enable insulation resistance up to 10^{13} ohms and surface charge density up to 3×10^{-9} coulombs/cm^2 to be measured.

The instrument is much used for the investigation of static charges in the textile, plastics, paper, rubber and explosives industries as well as in hospital operating theatres. Further details are given in leaflet No F.123 available on request.

BALDWIN *scientific instruments*

BALDWIN INSTRUMENT COMPANY LTD DARTFORD KENT • TEL 2948

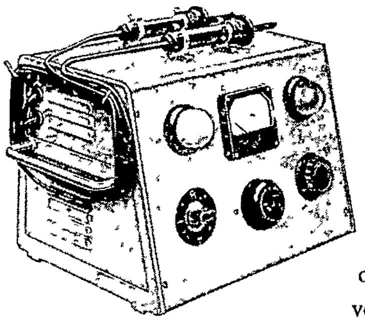
ZENITH

(REGD TRADE-MARK)

Insulation

FLASH TEST EQUIPMENT

with the unique safety test prods



Equipped with "VARIAC" primary control giving continuous HT voltage regulation from zero to maximum Standard outputs up to 2,000 volts and 3,000 volts

Illustrated brochure free on request

The ZENITH ELECTRIC CO. Ltd.

ZENITH WORKS, VILLIERS RD, WILLESDEN GREEN
LONDON, N W 2

Phone WILlesden 6581-5 *Grams* Voltaohm, Norphone, London

MANUFACTURERS OF ELECTRICAL ENGINEERING PRODUCTS INCLUDING RADIO AND TELEVISION COMPONENTS

Official repairing agents in Great Britain for Carl Zeiss of Jena and Bausch & Lomb, U.S.A.

C & P

ZEISS APPARATUS

We can undertake to overhaul and repair most Zeiss instruments Mr Perkins has specialized in Leitz and Zeiss instruments since 1909, and was in charge of the London repair shops of these firms for fifteen years When original spares are not obtainable, we can generally manufacture replacements

B. COOK & S. PERKINS

Pembroke Works, Pembroke Rd., Muswell Hill, London, N.10

Telephone TUDor 9731-2-3

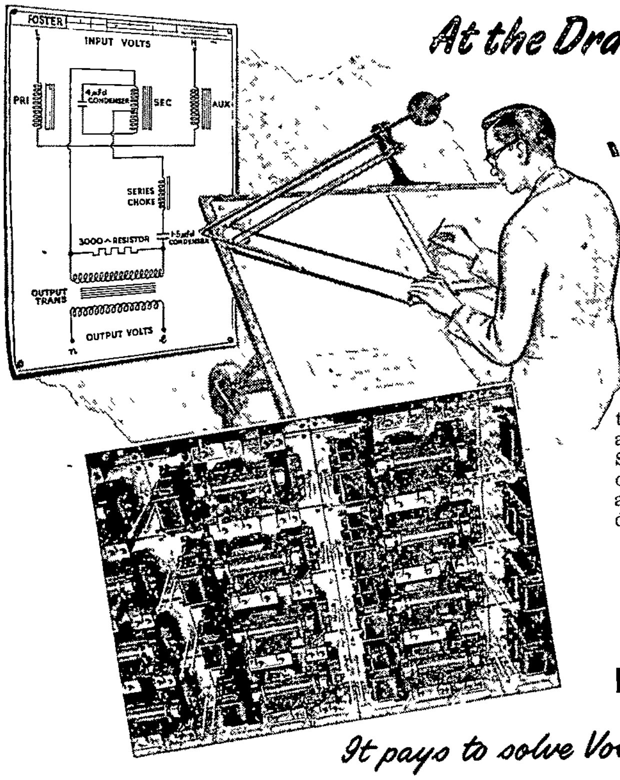
'Postlip' Papers are made by
EVANS, ADLARD & CO, LTD

Postlip

INDUSTRIAL FILTER PAPERS

Orders and enquiries to
TECHNICAL PAPER SALES LTD.
9, Bridewell Place, London, E.C.4
Telephone CENtral 9833

Write to Dept 3P for 'Postlip' Filter Paper Samples



At the Drawing Board Stage—

PLAN THE

'STABILISED POWER SOURCE'

OF YOUR EQUIPMENT

FOSTER Engineers will be pleased to help Hidden away in a wide variety of electrical apparatus is a Foster "C V " maintaining the characteristics so vital to research work, process work and indeed, every industrial application Foster "C V s' " are also used in Traffic Light Signals, Radar Control Circuits, Navigational Radio Beacons, Air and Sea, and for a wide variety of services in the armed forces Our picture shows a batch of Foster "C V s' " designed to suit a customer's particular requirements

FOSTER

CONSTANT VOLTAGE TRANSFORMERS

BUILT-IN COMPONENTS

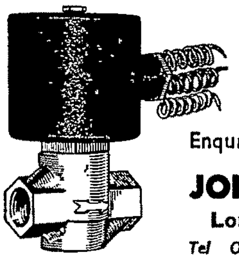
It pays to solve Voltage Problems before they happen!

FOSTER TRANSFORMERS LTD SOUTH WIMBLEDON LONDON S.W.19

A 'LANCASHIRE DYNAMO HOLDINGS' COMPANY

VR/2

Concordia Valves



SOLENOID VALVES

Temperature and Pressure

CONTROLS

Enquiries for special applications invited

JONES & STEVENS LTD.

Long Lane, Littlemore, Oxford

Tel Oxford 77912 Cables Instruments, Oxford

TRADE JAYGO MARK

Special & Standard Scientific Apparatus & Glassware

GLASS EQUIPMENT FOR FUME ABSORPTION

LABORATORY HOSPITALS AND PILOT PLANT EQUIPMENT FOR ANALYTICAL EDUCATIONAL AND RESEARCH PURPOSES

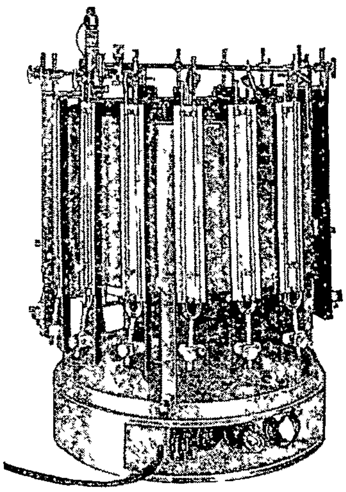
THE JAGO COMPANY

90 RUSHOLME ROAD, MANCHESTER, 13

HOSLAB
Regd Trade Mark
Laboratory Equipment

WARBURG CONSTANT VOLUME RESPIROMETER

(LEAFLET ON APPLICATION)



CIRCULAR BENCH MODEL

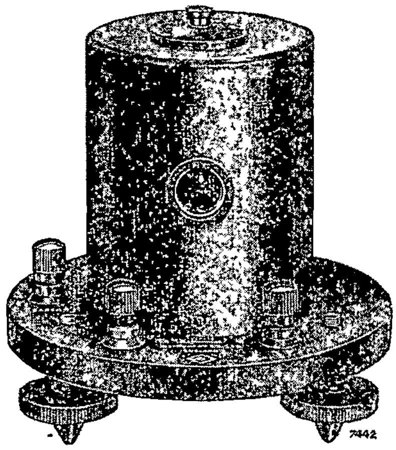
RECTANGULAR MODEL ALSO AVAILABLE

HOSPITAL AND LABORATORY SUPPLIES LTD.

12 CHARTERHOUSE SQUARE, LONDON, E.C 1

COMPLETE LABORATORY FURNISHERS

CAMBRIDGE *Flik* GALVANOMETER



This robust and sensitive Cambridge galvanometer has the exceptionally quick period of one-tenth of a second for the standard instruments with the performance given in the table. Instruments can be supplied with even shorter periods at a slight sacrifice of sensitivity.

Coil Res (ohms)	Periodic Time (secs)	Sensitivity mm/µA at 1 metre	Ext Res for Critical Damping (ohms)
300	0·1	100	4000
20	0·1	20	100

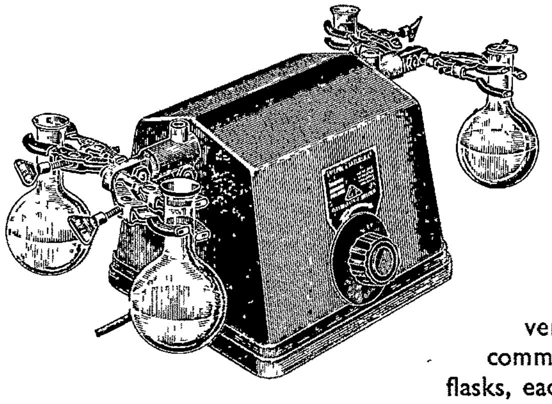
Details are given in
SHEET No. 288-N
May we send a copy?

CAMBRIDGE INSTRUMENT COMPANY LIMITED
13 GROSVENOR PLACE, LONDON S.W.1
WORKS LONDON AND CAMBRIDGE

THE MICROID FLASK SHAKER

REGISTERED DESIGN No 842861

- **SILENT, PORTABLE AND EFFICIENT**
- **VARIABLE SPEED** (*up to 500 oscillations per minute*)
- **WRIST ACTION**
- **"TIME and MOTION" REPEATABILITY**
- **IMMEDIATE DELIVERY**



The Microid Flask Shaker is an ideal labour-saving device for the modern laboratory In the daily routine operations of dissolving and dispersing solids, extracting residues and emulsifying oils, it not only abolishes the tedious process of prolonged shaking by hand, but also speeds up re-action. This versatile shaking machine accommodates up to four 500 ml flasks, each half-full of liquid, and can be controlled to give agitations varying in speed up to 500 oscillations per minute

B45–460 . **£26**

- **LONDON** Kemble Street, W C 2
- **BIRMINGHAM** Standley Belcher & Mason Ltd Church Street, 3
- **MANCHESTER** 19, Cheetham Hill Road, 4
- **GLASGOW** 45, Renfrew Street, C 2
- **EDINBURGH** 8, Johnston Terrace, 1

GRIFFIN & TATLOCK

(*A Division of Griffin & George Ltd*)

giving a resolution within 3 A., using currents as low as 10^{-19} amp. It was suggested that the technique has application, for example, to the investigations of fragmentization processes on metal catalysts.

The third session dealt with the investigation of surface phenomena using the field-emission microscope. Further discussion on adsorption and on the mobility of oxygen on tungsten was given in a paper by R. Gomer and J. K. Hulm (Chicago). Oxygen in the monolayer is not mobile below 450° K., and becomes a two-dimensional gas only at temperatures exceeding 700° K. The layers formed at low temperatures do not form at room temperatures. No changes in the chemisorbed layer are produced by heating in high vacuum to temperatures up to 600° K. Studies of the reaction of oxygen were described by E. A. Gulbransen (Westinghouse). Transmission optical methods have application in studies of chemical and physical reactions on metals as well as of the study of fine details of the substructure of the metal itself. A. T. Gwathmey (Virginia) described work on the nature of a metal surface as determined with the aid of large single crystals in the form of a surface exposing all possible faces, and also in a form of a flat surface exposing only specific faces. Study of surface processes such as etching, wetting, electrodeposition, and friction and wear, confirm the dependence of surface properties on crystal face. Oxidation of a copper crystal was shown on a coloured ciné film. P. W. Kruse (Notre Dame and Farnsworth) and E. A. Coomes (Notre Dame) described a study of the kinetics of strontium oxide on molybdenum. The pattern obtained on a heat-treated molybdenum point corresponds to that proposed for clean tungsten by Becker and by Muller.

The conference closed with a series of papers from Linfield College, Oregon. The stability of electron emission from metals in the combined presence of high surface electric field and elevated cathode temperature (*T–F* emission) was discussed by W. P. Dyke, and experiments using temperatures of 2,000° K. for tungsten were described, evaporation and surface migration being used to obtain a smooth clean surface. Stability of the field-emitter was discussed by E. E. Martin; instability can be due to the action of helium atoms, which diffuse through the tube envelope; the effect is removed by using an evacuated buffer space. Emission of current densities $\sim 5 \times 10^6$ amp./cm.^{2} from a single lattice step of clean tungsten was observed by J. K. Trolan using a pulse technique. W. W. Dolan described the dissolution of individual lattice planes made visible by the technique of high surface electric field and high cathode temperature, thus permitting a new approach to the study of transport mechanism at the emitter surface.

F. LLEWELLYN JONES

CHROMATOGRAPHY

An anonymous American Fulbright scholar, in a generous appreciation of his visit to the biochemistry department of an English university, wrote as follows: "It is certainly not entirely a misfortune that English laboratories to-day are much less lavishly equipped than those in the United States. For example, one of the most important advances of recent years has been the use of the method known as paper chromatography. To operate this method, one needs only a strip of moistened filter paper, suitably mounted in a box, and a few substances that can be bought from any dealer in pure chemicals. Yet by this technique complicated mixtures of numerous different amino acids or other substances can be sharply separated into their components, and then identified, even when separation by the methods of classical chemistry was impossibly tedious and ineffective. The method has come rapidly into use all over the world, for countless different kinds of problems. It is almost certainly no accident that this method was developed in England in the midst of all its shortages, toward the end of the war, rather than in the far more opulent United States" (Report on Fulbright Program, 1951–52, p. 23). However this may be (and one would not like to have the argument accepted too readily by those responsible for financing the universities), it is fair to say that British workers have been pioneers in the modern development of chromatography in its various aspects, and it is appropriate that the *British Medical Bulletin*, which is sponsored by the British Council, should publish a survey of this subject (Vol. 10, No. 3, pp. 161–252. London: British Council. 15*s* net).

Dr. C. E. Dent acted as scientific editor, and there are articles by nineteen authors who are all experts in their respective fields. Dr. A. J. P. Martin, who, jointly with Dr. R. L. M. Synge, received the Nobel Prize in 1952, was chairman of the planning committee and he writes the foreword. He outlines the immensely wide scope of chromatography, which has become an indispensable tool in almost all fields of biochemistry, and he ends by trailing his coat with the words, "I hope that chromatography may ultimately play some part in the process, which I believe to be wholly desirable, of the conversion of medicine from an art to a science". This is followed by a section on general principles of chromatography by Dr. R. J. P. Williams. For the benefit of newcomers to the subject, this might perhaps have been made a little more 'general' even at the risk of some overlapping with other articles. A large proportion of the limited space of this introductory section is devoted to gradient analysis, which is a rather specialized type of technique. There follows a brilliant chapter by Drs. A. T. James and A. J. P. Martin on gas–liquid chromatography, a technique which can be used to separate and estimate the members of a homologous series of substances such as hydrocarbons, alcohols, fatty acids, etc. This technique has a very wide scope and it is likely that in time it will completely replace analytical distillation. Some indication is given of the devices of these authors for estimating and automatically recording the substances after separation, devices which are elegant and ingenious in the extreme.

There are many references to adsorption chromatography and to ion exchange resins; but the main part of the volume is devoted to paper chromatography, starting with Dr. R. Consden's introduction, which is full of useful practical tips based on his wide experience as a pioneer in this technique. There seems to be a slip in the statement (p. 182) "if the R_F is too high in one solvent, a lower [sic] homologue may prove satisfactory". Other sections include the chromatography of inorganic substances, organic acids, proteins, peptides, amino-acids (dealt with in three sections), porphyrins, sterols, antibiotics and vitamins, carbohydrates and phosphoric esters. This last section, by Dr. F. A. Isherwood, is outstandingly good, as is Dr. R. Markham's review of nucleotide, work, with a mass of useful information compressed into a small space Dr J Gross deals with the thyroid hormones and includes an account of the recent discoveries which he and Mrs R Pitt-Rivers have made on the various iodine compounds in the thyroid gland and in the blood Much of this important work would have been impossible without the use of paper chromatography in combination with tracer technique using radioactive iodine, which permitted analyses to be made on an ultra-micro scale This article, and the one by Drs C E Dent and J M Walshe on amino-acid metabolism, are of direct medical appeal

Some of the articles contain a good deal of hitherto unpublished work, and each includes a bibliography which greatly adds to the value of the publication Incidentally, references to *Nature*, which is being regularly used as a forum for the recording and exchange of new chromatographic procedures, appear frequently in these bibliographies It seems a pity that all the illustrations in a volume entitled "Chromatography" should be produced in black-and-white Some private journals, notably *Endeavour*, have shown what æsthetically pleasing results can be achieved by the use of colour in illustrating chromatographic techniques, even if, from a purely scientific point of view, the gain does not justify the large extra cost. No worker who is interested in chromatography, whether beginner or expert, can fail to benefit from reading this admirable publication It is likely to be used on the laboratory bench as well as in the library, and it deserves to be protected from accidental 'paper chromatography' by being given a permanent binding D C HARRISON

THE EXPANDING UNIVERSE.

A SLIGHTLY modified version of a talk given by G J Whitrow in February 1953 in the B.B C Third Programme has now been published as a paper under the title of "The Orthodox Theory of the Expanding Universe" in the October issue of *Occasional Notes of the Royal Astronomical Society* (17, 3, 1954) A fairly large portion of the talk is concerned with a work by Paul Couderc, a French astronomer, which appeared in a French edition in 1950 and was translated into English by J B Sidgwick under the title "The Expansion of the Universe" (1952) The first part of the talk gives a very useful résumé of the developments in our knowledge of the universe during the past thirty years, in which period it was accepted that the universe extends far beyond the limits of our galaxy, and also that the red shift strongly suggested the recession of the extra-galactic nebulæ, all of which were moving away from one another The talk then considers other interpretations that have been given to the displacement towards the red end of the spectrum, dealing in particular with various matters connected with Couderc's book.

This book is recognized as a very useful contribution to cosmology in so far as it provides us with a simplified account of the mathematical theory of the expanding universe, but in recent years some British cosmologists have advocated a new theory based on the hypothesis of the continuous creation of matter.- Differences of view arise regarding the form in which this new matter emerges C. Pascual Jordan advocates the formation of super-giant stars, but other cosmologists who challenge this view have put forward the conception of new matter appearing in the form of hydrogen molecules or even neutrons, and the density of the universe remains constant, the decrease in density which would result from the recession of the galaxies being exactly balanced by the continuous creation of matter As might be expected, these theories have been subjected to severe criticisms, nevertheless, they are able to claim one strong argument in their favour—that they allow more time for stellar evolution than the older orthodox view which led to a conception of the earth being older than the galaxies This argument is no longer valid since Baade's announcement about the wrong 'calibration' of the distances of the Cepheid variables (the investigations of Thackeray and Wesselink on the distance of the Magellanic Clouds have corroborated Baade's conclusions), now it seems that it must have been about four thousand million years ago since the universe started expanding, and in addition, the distances of the extra-galactic nebulæ must now be taken as twice those previously estimated.

Whitrow concludes with an expression of disagreement with Couderc's acceptance of the two fundamental hypotheses at the basis of the 'orthodox' theory of the expanding universe, these are that the red shifts are due to the Doppler effect associated with recessional motion, and also that the laws of Einstein's general theory of relativity, either with or without the idea of cosmical repulsion, govern the structure of the universe as a whole He thinks that neither of these is on such firm foundations as Couderc believes, but in spite of this disagreement he speaks highly of the latter's book which, on p. 213, seems to express a little doubt on the inadequacy of some of his own arguments "Everything possible has been extracted from existing observations, until the appearance of new data we would be wise to give our imaginations a rest" To this remark Whitrow makes the very relevant reply " . . if such advice had been accepted by Copernicus he would never have ventured beyond the Ptolemaic theory".

RECENT MOLLUSCA OF CANADA

THE great extent of Canada has resulted, and will probably long result, in its molluscan fauna being studied in four separate areas the Eastern Provinces, British Columbia, the Arctic region based on Hudson Bay, and the Prairie Provinces. In the first three, marine, freshwater and land forms are involved, but in the fourth only freshwater and land. Partly for this reason and also because many of the species were first described from other countries, the literature involved is extensive and scattered.

A very useful service in rendering this literature and its results available for the whole of Canada has been performed by the publication of Bulletin No. 129 of the National Museum of Canada, entitled "Catalogue of the Recent Mollusca of Canada", by Dr. Aurèle La Rocque (Biological Series No. 44. Pp. ix+406 Ottawa · Queen's Printer, 1953, 2 50 dollars). It fills a very obvious gap, for it provides a list of the accepted species and forms that have so far been recorded, numbering about 2,250 The author has wisely included forms that have actually only been described from adjacent seas and land areas, where it may reasonably be inferred that more extensive collecting will lead to their being found within the strict territorial limits. Under each form are given the original reference and, where known, the type locality, references to papers containing further data, and the known range. A complete synonymy is not given for any species; but it can be obtained from the references. In some instances one or, more rarely, two synonyms in use in previous Canadian records are provided. Future collecting will no doubt add to the list considerably, but it will also be liable to reduce it when the method adopted by Hubendick for *Lymnaea peregra* is applied to some of the freshwater forms. The number of species of some genera, for example, Odostomia from the Pacific coast, that are only known from the one record from the type locality, implies that more extensive collecting will show some of them to be members of highly variable rather than separate species.

Two minor points suggest that a more careful check of dates might have been made: for example, on p. 2, the author states that it is unnecessary to give references to the original founding of genera because they are given by Neave (1935), but, as correctly cited in the bibliography, the earliest date of Neave is 1939; the date of Mozley's paper on *Stagnicola traskii castorensis* is given as 1930 in the text, but 1931 in the bibliography. However, on the whole there is nothing but praise for this well-printed and well-presented catalogue, which could only have been prepared so satisfactorily by one like Dr. La Rocque, who combines critical enthusiasm with a long personal acquaintance with his subject.

INFLUENCE OF MONOLAYERS ON THE NATURAL RATE OF EVAPORATION OF WATER

By W. W. MANSFIELD

Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization, Melbourne

FOR many years it has been known that the presence on water surfaces of monolayers of a number of long-chain compounds or of layers of appropriate oil mixtures may restrict the evaporation of water[1,2]. Apart from this property, a film suitable for reducing natural evaporation from water storages must resist the actions of wind and dust, must be reasonably permanent and capable of ready and economic application, should not restrict markedly the access of air and sunlight to the water, and must not be toxic. In this communication there are summarized a number of results which indicate that monolayers of cetyl alcohol satisfy these requirements.

Action of wind and dust. In this laboratory it has been found that rigid films, such as monolayers of long-chain fatty acids or oil layers containing appropriate additives, are damaged by both wind and dust. As the rigidity of the film also hinders repair, the ability to retard evaporation is lost rapidly.

With more fluid oil films, the inevitable reversion to the system of lenses in equilibrium with a monolayer is hastened by wind and dust. A monolayer of this type of film does not offer great resistance to the transfer of water vapour, and the restriction provided by the lenses is reduced markedly by settled dust. Accordingly, under natural conditions the efficiency of such systems decays rapidly.

Provided excess crystals of the solid from which it is derived are available, the efficiency of a liquid monolayer, such as that formed by a long-chain alcohol, is unimpaired by the action of wind. It has been observed also that the performance of this system is not diminished by bombardment with dust; in fact, the resistance to transfer of vapour is increased temporarily. Only materials such as powdered talc and carbon, capable of remaining on the surface for some time, cause a decline in efficiency. The occurrence of considerable proportions of these substances in natural dust is not common.

Performance of monolayers. The resistances offered to the transfer of water vapour by a number of monolayers, formed on still surfaces by spreading from the solid, have been determined. The apparatus used resembled that described by Langmuir and Schaefer[3]. It has been found that straight-chain alcohols generate monolayers providing greater retardation than those formed from alcohols containing branched chains or ring skeletons within the molecule. For the straight-chain alcohols, most efficient restriction is obtained with monolayers of cetyl or stearyl alcohol. At room temperature, these two films exhibit very similar behaviour, offering a resistance to vapour transfer about 1,600 times greater than that of a clean water surface, for which an accommodation coefficient of 0.036[4,5] has been assumed. The accommodation coefficient of monolayers does increase with temperature, however; for cetyl alcohol the rise is from 2.2×10^{-5} at 20° C. to 7.9×10^{-5} at 50° C.

Out of doors, the laminar layer of air above a water surface provides a resistance which is normally about eight hundred times that of the water surface alone. The presence of a monolayer of cetyl alcohol results in a total resistance which is three times greater; accordingly, the monolayer should reduce natural evaporation by about 70 per cent. Any reduction in evaporation, however, promotes an increased surface temperature. The consequent compensation, the extent of which varies with the wind velocity, the depth of water and the radiation received by the water, is not excessive for average conditions. A previous conclusion[6] that this compensating effect prevents significant control of evaporation is quite incorrect; it was influenced by poor results obtained with imperfectly developed monolayers spread on small and shallow samples of water. The construction of heat balances, somewhat after the manner of Ferguson[7], predicts a mean reduction of about 45 per cent for normal summer conditions in inland southern Australia.

Diminution of evaporation to this extent admittedly is not spectacular, but may be achieved without any significant decrease in the rate of access of oxygen or other gases to the water, and also without hindering the penetration of light. Severe restriction of evaporation by a film alone should be avoided, because the influx of oxygen may be retarded sufficiently to promote stagnation. Similarly, the combined use of floating reflecting surfaces and a monolayer[8] inhibits evaporation to a much larger extent than does a monolayer alone, but the entry of sunlight is restricted also.

Attainment of optimum performance. The estimates presented are based on results obtained for a monolayer in equilibrium with the solid, that is, at a surface pressure of 40 dyne cm.$^{-1}$ The true surface area of a natural stretch of water varies continuously, engendering a variable surface pressure of a monolayer spread on it unless means of replenishment and storage are available. Compression of a liquid monolayer forces rapid crystallization of excess molecules, so that the existence of surface pressures greater than 40 dyne cm^{-1} may be disregarded. On the other hand, expansion of a monolayer produces marked degeneration of surface pressure; an expansion of 10 per cent is sufficient to lower the pressure from 40 dyne cm^{-1} to practically zero. It follows that the mean pressure on a disturbed surface will always be less than 40 dyne cm.$^{-1}$ unless an adequate method of replenishment is provided. As the restriction offered to evaporation decreases rapidly with decrease of surface pressure[2,3], such provision is necessary. The presence of excess solid material, stored in suitably designed rafts when necessary, constitutes a convenient reservoir.

The efficiency of these reserves is proportional to the total perimeter of the solid in contact with the water surface and the rate of liberation of molecules from unit perimeter of the solid, and is inversely proportional to the area of the stretch of water. Accordingly, the measurement of rates of spreading and the determination, from the data of Sverdrup and Munk[6], of the maximum rate of disturbance of natural water surfaces has permitted estimation of the amounts of cetyl alcohol for maximum performance.

The estimates indicate that for pure crystalline cetyl alcohol a perimeter/area ratio of 10^{-3} cm^{-1} should be ample for most applications, greater doses being required only in areas of abnormally high mean wind velocities or when small dams are treated. For particles about 3 mm. in diameter and 0·5 mm. thick, a concentration of 3 cwt. mile^{-2} is sufficient.

Samples of cetyl alcohol possessing spreading rates very much greater than that of pure crystalline cetyl alcohol may be prepared readily. Enhancement follows from the existence of a high-energy, amorphous surface or from the presence of homologous alcohols of lower molecular weight. In contact with water, however, the rate of spreading of such materials decreases. Consequently, for the estimates mentioned above, the minimum rate has been assumed. Similarly, the replenishing ability of the aggregates produced by relaxation of a previously disturbed surface has been ignored.

The achievement of optimum performance requires also that the concentration of deleterious impurities within the cetyl alcohol used is low. Long-chain unsaturated alcohols such as oleyl alcohol must be removed, because monolayers relatively permeable to water vapour are spread rapidly from these compounds. Experiments in this laboratory indicate that a sample of cetyl alcohol is sufficiently pure if the solid is white and the molten material quite colourless, and if the melting point of the preparation lies between 47° and 51° C.

Field-trials. The limited trials conducted to date have provided encouraging results. Between September and December 1953, Mr. W. C. Swinbank, of the Section of Meteorological Physics, Commonwealth Scientific and Industrial Research Organization, continuously obtained restriction of evaporation from a vessel about 18 in. in diameter and 3 ft. deep, using a single pellet of cetyl alcohol to give a perimeter/area ratio of about 1·5 × 10^{-3} cm.$^{-1}$. By comparison with the behaviour of water held in an adjacent and identical vessel, it was estimated that about 6 in. of water was saved during the period. The temperature near the surface of the treated water was always greater than that of the control, the increment varying with conditions from 0·2 to 3 deg. C.

Dusting a surface with cetyl alcohol powder initially engenders marked control of evaporation. With the passage of time, however, agglomeration of the powder occurs and decreased efficiency results. During September 1953, the evaporation from vessels 12 in. in diameter and 18 in. deep was reduced by 75 per cent for the first week, by 45 per cent for the second week, whereas no significant retardation was observed thereafter. In this instance the mean evaporation from the control was 0·8 in. per week.

Subsequent experiments in similar vessels, using pellets of cetyl alcohol of known perimeter, revealed that maximum control of evaporation is not attained in vessels of this size unless the perimeter/area ratio exceeds 5 × 10^{-3} cm^{-1}. When sufficient cetyl alcohol was available, evaporation was reduced by an average of 48 per cent for various periods between October 1953 and January 1954, with a mean evaporation from the control of 1·5 in. per week.

Early in November 1953, the surface of a reservoir at Woomelang, Victoria, and extending over two acres, was treated with pellets of cetyl alcohol supported by rafts constructed from waterproofed wood and copper gauze. The nominal perimeter/area ratio of 1·1 × 10^{-5} cm.$^{-1}$ was much smaller than that now considered desirable (7 × 10^{-4} cm.$^{-1}$), but temporarily was undoubtedly higher following the ejection of fragments from the pellets during spreading. Within an hour of seeding, the normal surface pressure of 2 dyne cm.$^{-1}$ had risen to 20 dyne cm.$^{-1}$, which value was observed again five weeks later. Comparison of the levels of this with an immediately adjacent and untreated reservoir indicated a decrease in apparent evaporation during rainless periods of 30 per cent. The advent of rain, however, revealed the intake of the control reservoir to be greater. Accordingly, it cannot be stated that the observed decrease in apparent evaporation followed from the presence of a surface film, as it may have been caused by differing rates of seepage, which appeared to be high and erratic.

In January 1954, a bank of five standard evaporimeters, of diameter 3 ft., was installed by the Section of Meteorological Physics at Aspendale, Victoria. For the remainder of the summer, efficient restriction of evaporation was obtained only over limited periods. Eventually it was found that a rigid film, sufficiently thick to be easily visible, provided the obstacle to success. The film, which is presumed to result from the presence of frogs in the evaporimeters and resembles that formed on water approaching stagnation, retards considerably the rate of spreading of cetyl alcohol. It has been found that efficient control in these circumstances requires periodic displacement of the rigid film with a solution of cetyl alcohol in a volatile solvent, the interval between displacements depending on the concentration of solid cetyl alcohol which is then placed upon the surface. This variant of the usual process will be desirable on many small dams.

Working life of the treatment. It was observed initially by Mr. W. C. Swinbank that retardation of evaporation becomes insignificantly small only after a lapse of about four days following the removal of the solid material from which a film has spread Much of this persistence may be ascribed to the action of micro-reservoirs, formed and utilized continuously by reduction and extension of the true area of the water surface Assuming, however, that cessation of activity follows only from solution in the water of sufficient of the monolayer, it has been estimated that the life of a dosage of 3 cwt mile^{-2} is at least ten years. Should this value prove to be even several-fold too great, the process remains quite economic.

Future work These summarized results are considered sufficiently promising to warrant further and extensive trials. A number of stretches of water, both large and small, throughout Australia will be treated during the coming summer The Director of the East African Meteorological Department has indicated that similar work is contemplated by his Department, and Dr. J H. Schulman, of the University of Cambridge, has expressed an intention to carry out large-scale experiments. Accordingly, a comprehensive evaluation of the method should be available within two years

Progress in this work has been accelerated considerably by the advice, criticism and assistance of Mr. W. C. Swinbank and Dr. C. H. B Priestley, of the Section of Meteorological Physics of the Commonwealth Scientific and Industrial Research Organization. Acknowledgments are due also to Dr. K. L Sutherland, Division of Industrial Chemistry, to Mr R. Penman, Section of Meteorological Physics, of this Organization, and to Mr. L N. Welsh, Mr R. G. Upstill, Mr. J Wise and Mr. R Cook, of the Victorian State Rivers and Water Supply Commission.
[Sept. 27.

[1] Adam, N K , *J Phys Chem* , 29, 610 (1925) Rideal, E K , *J Phys Chem* , 29, 1585 (1925) Baranaev, M , *J Phys Chem U S S R* , 9, 69 (1937) Glazov, N I , *J Phys Chem U S S R* , 11, 484 (1938) Docking, A R , Heymann, E , Kerley, L F , and Mortensen, K N , *Nature*, 146, 265 (1940) Powell, R W , *Trans Faraday Soc* , 39, 311 (1943) Gilby, A R , and Heymann, E , *Aust J Sci Res* , A, 1, 197 (1948)
[2] Sebba, F , and Briscoe, H V A , *J Chem Soc* , 106 (1940)
[3] Langmuir, I , and Schaefer, V J , *J Franklin Inst* , 235, 119 (1943)
[4] Alty, T , *Phil Mag* , 15, 82 (1933)
[5] Baranaev, M , *J Phys Chem U S S R* , 13, 1635 (1939).
[6] Mansfield, W W , *Nature*, 172, 1101 (1953)
[7] Ferguson, J , *Aust J Sci Res* , A, 5, 315 (1952)
[8] Sverdrup, H U , and Munk, W H., U S Hydrographic Office Tech Report No 601 (1947)

SYNTHESIS OF CARBOHYDRATES FROM CARBON DIOXIDE AND HYDROGEN IN A CELL-FREE SYSTEM

By DR. E RACKER

Division of Nutrition and Physiology, Public Health Research Institute of the City of New York

CALVIN and his collaborators were the first to demonstrate[1] that a few seconds after photosynthesizing cells are exposed to carbon-14 dioxide, radioactivity can be found in 3-phosphoglyceric acid. The discovery of sedoheptulose phosphate and ribulose diphosphate in extracts of photosynthesizing cells led to the proposal of a mechanism in which ribulose diphosphate acted as the primary acceptor of carbon dioxide, yielding two moles of 3-phosphoglyceric acid on cleavage[2] Regeneration of the carbon dioxide acceptor was proposed to occur by a cyclic process in which transketolase, transaldolase and some glycolytic enzymes participate. Carboxylation of this acceptor was shown to occur also in cell-free extracts obtained from *Chlorella*[3]. Recently, evidence for the carboxylation of pentose phosphate in cell-free extracts from spinach with ribose-5-phosphate as substrate was obtained independently by Cowperthwaite and Racker (unpublished results), and by Weissbach, Smyrniotis and Horecker[4]

It is the purpose of this communication to present evidence for a cyclic process and to report the net synthesis of carbohydrates from carbon dioxide and reduced diphosphopyridine nucleotide, adenosine triphosphate and catalytic amounts of ribose-5-phosphate in the presence of a fractionated enzyme preparation from spinach Either alcohol, in the presence of alcohol dehydrogenase, or hydrogen, in the presence of diphosphopyridine nucleotide-linked hydrogenase, was used as hydrogen donor for the reduction of the pyridine nucleotide When reduced diphosphopyridine nucleotide was regenerated with hydrogen, the major precursors of the carbon, oxygen and hydrogen of the carbohydrate thus synthesized were carbon dioxide and molecular hydrogen. Adenosine triphosphate supplied the required energy

The Pentose Phosphate Cycle and its Enzymes

Before a net synthesis of carbohydrate in a cell-free system can be explained, a balanced equation representing a series of reactions catalysed by demonstrable enzymes is required (Table 1) All enzymes listed in Table 1 can be readily shown to occur in cell-free extracts However, some of the intermediates of the reactions have not been fully characterized and further purification of the component enzymes is still required The cyclic operation of these reactions is shown in Fig. 1.

Table 1 THE PENTOSE PHOSPHATE CYCLE*

Reaction	Enzyme
(1) 3 pentose-p + 3 ATP → 3 "RDP" + 3 ADP	Phosphopentokinase
(2) 3 "RDP" + 3 CO_2 + 3 H_2O → 6 PGA	"RDP" carboxylase
(3) 6 PGA + 6 ATP → 6 diPGA + 6 ADP	PGA-kinase
(4) 6 diPGA + 6 DPNH + 6 H^+ → 6 triose-p + 6 DPN + 6 P_i	Triose-p dehydrogenase
(5) 4 triose-p → 2 HDP	Aldolase, triose-p isomerase
(6) 2 HDP + 2 H_2O → 2 HMP + 2 P_i	HDP-ase
(7) 1 HMP + 1 triose-p → 1 pentose-p + 1 tetrose-p	Transketolase
(8) 1 HMP + 1 tetrose-p → 1 heptulose-p + 1 triose-p	Transaldolase
(9) 1 heptulose-p + 1 triose-p → 2 pentose-p	Transketolase

Sum (1–9) $3CO_2 + 9ATP + 5H_2O + 6DPNH + 6H^+ \rightarrow 1 \text{ triose-p} + 9ADP + 6DPN + 8P_i$

(10) $9H_2O + 9DPN \rightarrow 9DPNH + 9H^+ + 9O$

(11) $3DPNH + 9ADP + 9P_i + 3H^+ + 3O \rightarrow 3DPN + 9ATP + 12H_2O$

Sum (1–11) $3CO_2 + 2H_2O + P_i \rightarrow 1 \text{ triose-p} + 6O$

* The following abbreviations, among others, have been used ATP and ADP for adenosine triphosphate and adenosine diphosphate, DPN and DPNH for oxidized and reduced diphosphopyridine nucleotide, P_i for inorganic phosphate and -p for organically bound phosphate, HDP for fructose-1,6-diphosphate, and HMP for either glucose-6-phosphate or fructose-6-phosphate

Phosphopentokinase (Reaction 1) The enzyme which catalyses the formation of ribulose diphosphate[5] in the presence of ribose-5-phosphate and adenosine triphosphate will be referred to as phosphopentokinase[6]. It should be pointed out that the substrate for this kinase has not yet been identified Since it has been shown (de la Haba, G L, and Srere, P. A, unpublished results) that a preparation of highly purified phosphopentose isomerase from alfalfa leaves[7] transforms ribose-5-phosphate into a mixture of ketosugar phosphates of which only a small portion is ribulose-5-phosphate (susceptible to the action of transketolase), the possibility of a substrate other than ribulose-5-phosphate must be considered The product of the kinase reaction has been shown to be a ketosugar diphosphate[6] The compound is here referred to as ketopentose diphosphate or "RDP", since the available evidence does not seem to rule out configurations other than the 2-ketoribose (for example, a 3-ketoribose)

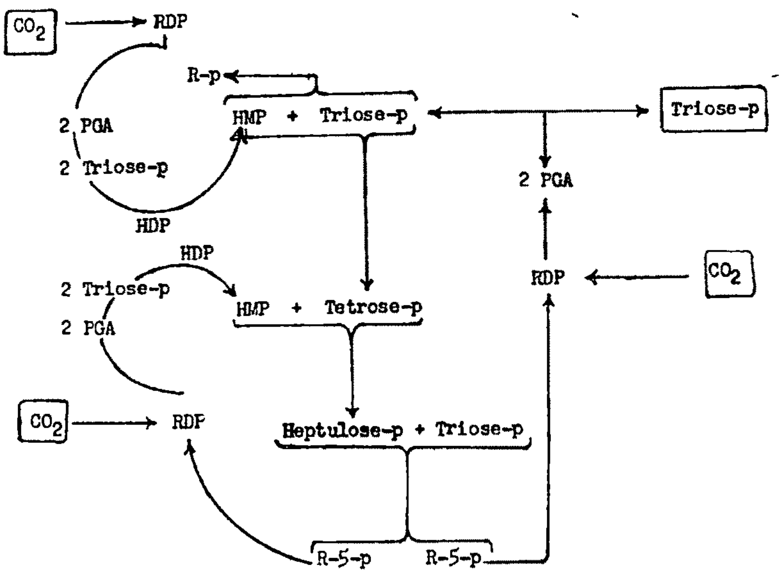
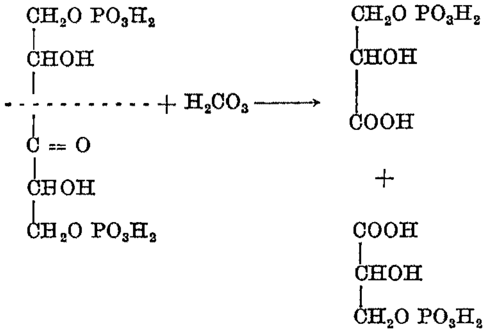


Fig 1 The pentose phosphate cycle

"*RDP*" *carboxylase* (Reaction 2). This enzyme catalyses the cleavage of ketopentose diphosphate to two moles of 3-phosphoglyceric acid in the presence of bicarbonate (Jacobi, W., personal communication) Calvin and his collaborators proposed the formation of an ene-diol of ribulose diphosphate which adds carbon dioxide to form an unstable α-hydroxy-β keto acid The latter would then be hydrolysed to form two moles of 3-phosphoglyceric acid

An alternative mechanism might be proposed involving the formation of a 3-ketopentose diphosphate which is cleaved by bicarbonate to two moles of 3-phosphoglyceric acid as follows



$$\begin{array}{l} CH_2O\ PO_3H_2 \\ | \\ CHOH \\ | \\ \text{- - - - - - - -} \\ | \\ C=O \\ | \\ CHOH \\ | \\ CH_2O\ PO_3H_2 \end{array} + H_2CO_3 \longrightarrow \begin{array}{l} CH_2O\ PO_3H_2 \\ | \\ CHOH \\ | \\ COOH \\ \quad + \\ COOH \\ | \\ CHOH \\ | \\ CH_2O\ PO_3H_2 \end{array}$$

Glycolytic enzymes (Reactions 3–6). The phosphorylation of 3-phosphoglyceric acid to diphosphoglyceric acid is catalysed by phosphoglyceric kinase, the reduction of diphosphoglyceric acid to triose phosphate by triose phosphate dehydrogenase in the presence of reduced pyridine nucleotides, and the condensation of triose phosphates to fructose-1,6-diphosphate by aldolase, these enzymes have been demonstrated in extracts from various plants

The formation of fructose-6-phosphate from fructose-1,6-diphosphate is known to occur in liver[8] and is now shown to be catalysed by a specific enzyme which has been purified over a hundredfold from spinach extracts The enzyme activity is dependent on magnesium ions Further stimulation (about fourfold) is obtained by addition of ferrous salts and ethylenediamine tetraacetate No hydrolysis of several monophosphate esters of hexoses and pentoses could be detected in the presence of the purified enzyme

Enzymes of the glucose-6-phosphate shunt (Reactions 7–9). A cycle of glucose-6-phosphate oxidation in which the first three carbons of glucose are oxidized to carbon dioxide, while carbons 3, 4 and 5 form a triose phosphate, was discussed in a recent review[9] It can be postulated that a condensation of two triose phosphates to fructose-1-6-diphosphate, which is hydrolysed to fructose-6-phosphate, followed by another turn of the cycle, can lead to the complete oxidation of glucose to carbon dioxide and water Reactions 7–9 in Table 1 represent part of this glucose-6-phosphate cycle, written in reverse order and linked to a reductive step catalysed by triose phosphate dehydrogenase instead of to the oxidative step catalysed by glucose-6-phosphate dehydrogenase Carboxylation of "RDP", instead of the decarboxylation of 6-phosphogluconic acid, takes place in the plant cycle.

New Assay Methods and Purification of the Enzymes of the Pentose Phosphate Cycle

The elucidation and fractionation of the system described above have been greatly facilitated by the use of rapid assay systems which were developed for the individual reactions.

Phosphopentokinase This enzyme can be assayed by a manometric method similar to that used for hexokinase determinations[10]. However, it is essential for the activity of this enzyme to add glutathione (or other SH compounds) The enzyme is inhibited by N-ethyl maleimide

A more convenient and accurate assay for adenosine triphosphate-linked kinases has been used preferentially in our laboratory. It is based on the colorimetric determination of acyl phosphates by the hydroxylamine reaction of Lipmann and Tuttle[11] With a purified preparation of acetokinase[12], catalytic amounts of adenosine triphosphate and excess of

Table 2 ASSAY OF PHOSPHOPENTOKINASE WITH THE ACETO KINASE SYSTEM

	µmoles acetyl phosphate disappeared
Complete test system (cf text)	
containing 0 1 ml of spinach fraction	1 8
containing 0 2 ml of spinach fraction	3 5
containing 0 3 ml of spinach fraction	5 0
Test system	
containing 0 2 ml of spinach fraction but no ribose-5-phosphate	0 2
Test system without spinach fraction	0 2

acetyl phosphate, the latter compound disappears only in the presence of an acceptor system for the terminal phosphorus of adenosine triphosphate The test system contained in a final volume of 1 ml, 50 µmoles of tris (hydroxy) aminomethane buffer, pH 7 4, 5 µmoles of magnesium chloride, 1 µmole of adenosine triphosphate, 5 µmoles of glutathione, 8 µmoles of lithium acetyl phosphate, 20 units of acetokinase, 7 µmoles of ribose-5-phosphate and the enzyme solution to be tested After 10 min. at 25° C, determination of acetyl phosphate was carried out on the entire sample A typical assay for phosphopentokinase is shown in Table 2 The enzyme has been purified about twenty-five fold by fractionation with acetone (33–50 per cent), ammonium sulphate (20–50 per cent) and isoelectric fractionation.

"RDP" carboxylase. The formation of phosphoglyceric acid was measured spectrophotometrically. In the presence of excess phosphopentokinase, phosphopentose isomerase, adenosine triphosphate, magnesium ions, phosphoglyceric kinase and glyceraldehyde-3-phosphate dehydrogenase, the oxidation of reduced diphosphopyridine nucleotide is dependent on the "RDP" carboxylase The measurements were carried out in a Beckman *DU* spectrophotometer as 340 mµ The enzyme has been purified eighteen-fold with ammonium sulphate (20–50 per cent), alcohol (14–19 per cent) and isoelectric fractionation

Transketolase, transaldolase and hexose diphosphatase. Transketolase was measured by triose phosphate formation in the presence of an equilibrium mixture of ribose-5-phosphate and ribulose-5-phosphate ('isomerase product'). The details of the test and crystallization of the enzyme from yeast have been described[13]

Transaldolase was measured with glucose-6-phosphate dehydrogenase 'Isomerase product' and transketolase were used to generate heptulose phosphate and triose phosphate The details of the test and the purification of the enzyme from *Torula* yeast will be described elsewhere[14]

Hexose diphosphatase was measured also with glucose-6-phosphate dehydrogenase in the presence of hexose phosphate isomerase Alternatively, the rate of liberation of inorganic phosphate from fructose-1,6-diphosphate was determined Separation of the enzyme from "RDP" carboxylase and phosphopentokinase has been achieved by ammonium sulphate fractionation and the use of calcium phosphate gel

Overall Reaction and the Synthesis of Hexose Phosphate

The sum of reactions 1–9 reveals that triose phosphate should be synthesized from carbon dioxide and water if adenosine triphosphate and reduced diphosphopyridine nucleotide are provided in the presence of the appropriate multi-enzyme system Ribose-5-phosphate or any precursor system for ribose-5-phosphate or ribulose-5-phosphate should serve in only a catalytic fashion.

The regeneration of adenosine triphosphate from the diphosphate by coupled phosphorylation and the reduction of diphosphopyridine nucleotide by photolytic cleavage of water[15] can provide the energy and the reducing agent (reactions 10 and 11) required for the total synthesis of carbohydrate from carbon dioxide and water. These two key reactions of photosynthesis have been demonstrated in cell-free systems[15,16]

Large amounts of adenosine triphosphate were added in the present experiments in order to avoid the use of grana which catalyse oxidative phosphorylation Reduced diphosphopyridine nucleotide was generated with hydrogen and a diphosphopyridine nucleotide-linked hydrogenase (kindly supplied by Mr L Packer and Dr. W Vishniac) or with alcohol and alcohol dehydrogenase

As shown in Table 3, synthesis of hexose phosphate takes place in the purified system. Stimulation by bicarbonate was demonstrated, as well as dependency on catalytic amounts of pentose phosphate and a reducing system Transketolase, transaldolase and phosphopentokinase are present in non-limiting quantities in the "RDP" carboxylase preparations from spinach, and a pronounced stimulation of hexose monophosphate formation by addition of these enzymes has therefore not as yet been achieved.

Table 3 SYNTHESIS OF HEXOSE MONOPHOSPHATE FROM CARBON DIOXIDE, REDUCED DIPHOSPHOPYRIDINE NUCLEOTIDE AND ADENOSINE TRIPHOSPHATE

	µmoles of hexose monophosphate
Complete system*	1 6
Potassium bicarbonate omitted	0 5
Ribose-5-phosphate omitted	0 3
Hydrogen and hydrogenase omitted	0 4

* The complete system contained the following components in a final volume of 1 ml tris (hydroxy) aminomethane buffer (pH 7 6), 50 µmoles, potassium bicarbonate, 50 µmoles, ribose-5-phosphate, 0 25 µmole, magnesium chloride, 2 5 µmoles, diphosphopyridine nucleotide, 0 5 µmole, glyceraldehyde-3-phosphate dehydrogenase, 1 mgm, phosphoglyceric kinase, 65 µgm, aldolase, 280 µgm, spinach fraction (3 5 mgm) containing phosphopentose isomerase, kinase, carboxylase, transketolase, transaldolase and hexose diphosphatase, glutathione, 5 µmoles, adenosine triphosphate, 40 µmoles, and 1 5 mgm of a hydrogenase preparation The mixture was incubated at 25° under hydrogen for 60 min and then assayed for fructose-6-phosphate

The results here reported therefore demonstrate the operation in cell-free spinach fractions of a cyclic mechanism leading to the net synthesis of carbohydrate from carbon dioxide and hydrogen in aqueous solutions.

[1] Calvin, M., "The Harvey Lectures", 46, 218 (1950–1951) (C C Thomas Publ Co, Springfield, Ill)

[2] Bassham, J A, Benson, A A, Kay, L D, Harris, A Z, Wilson, A T, and Calvin, M, *J Amer Chem Soc*, 76, 1760 (1954)

[3] Quayle, J R, Fuller, R C, Benson, A A, and Calvin, M, *J Amer Chem Soc*, 76, 3610 (1954)

[4] Weissbach, A, Smyrniotis, P Z, and Horecker, B L, *J Amer Chem Soc*, 76, 3611 (1954)

[5] Benson, A A, Bassham, J A, Calvin, M, Hall, A G, Hirsch, H E, Kawaguchi, S, Lynch, V, and Tolbert, N E, *J Biol Chem*, 196, 703 (1952)

[6] Weissbach, A, Smyrniotis, P Z, and Horecker, B L, *J Amer Chem Soc*, 76, 5572 (1954)

[7] Axelrod, B, Bandurski, R S, Greiner, C M, and Jang, R, *J Biol Chem*, 202, 619 (1953)

[8] Gomori, G, *J Biol Chem*, 148, 139 (1943)

[9] Racker, E, "Advances in Enzymol", 15, 141 (1954)

[10] Colowick, S, and Kalckar, H M, *J Biol Chem* 148, 117 (1943)

[11] Lipmann, F, and Tuttle, L C, *J Biol Chem*, 159, 21 (1945)

[12] Rose, I A, Grunberg-Manago, M, Korey, S R, and Ochoa, S, *J Biol Chem*, 211, 737 (1954) Purified preparations of acetokinase were kindly supplied by Drs Korey and Grunberg-Manago

[13] de la Haba, G L, Leder, I G, and Racker, E, *J Biol Chem* (in the press)

[14] Srere, P A, Kornberg, H L, and Racker, E, *Fed Proc* (in the press)

[15] Vishniac, W, and Ochoa, S, "Phosphorus Metabolism", 2, 467 (1952)

[16] Millerd, A, Bonner, J, Axelrod, B, and Bandurski, R, *Proc U S Nat Acad Sci*, 37, 855 (1951)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications

Use of the Nitric Oxide/Oxygen Continuum in the Estimation of the Relative Concentrations of Oxygen Atoms in Flame Gases

Gaydon[1,2] has observed that when nitric oxide is added to flames which are likely to contain free atoms of oxygen, a greenish continuum is observed in emission, which is ascribed to a radiative combination

$$NO + O \rightarrow NO_2 + h\nu$$

This identification is highly probable, and is strongly supported by quantitative measurements which we have made of the intensity of the continuum Mixtures of hydrogen and air of known composition have been burned, after mixing, in a Mèker type of burner, to give a flame about 2 cm. in diameter with cones of primary combustion only a few millimetres in height. These flames were surrounded by similar ones, but with separate supplies, giving an overall diameter of about 4 cm, the sheath thus preventing the formation of a cool boundary to the inner flame, and protecting it from the effects of indrawn air.

Attention was focused mainly on the interconal gases a few centimetres above the primary cones, since it is there that fair thermal equilibrium is to be expected The temperature of the inner column was measured by the method of reversal of the sodium D line[3], the metal being added as traces of fine spray of sodium chloride solution to the inner air supply. The composition of the interconal gases at this temperature was then calculated from the known composition of the unburned gases and the relevant data on equilibrium constants given by Lewis and von Elbe[4] In particular, the concentration of free oxygen atoms was obtained, for a series of flames ranging from near stoichiometry to about twice the stoichiometric proportion of hydrogen Temperatures ranged from 2,050° to 2,290° K.

A small amount of nitric oxide was then fed into the supply to the inner flame The reaction zone showed the green continuum very strongly, and this persisted, more weakly, into the interconal gases Its intensity, the spectral variation of which remained constant, was measured by a photo-multiplier and amplifier system mounted in place of the plate-holder on a Hilger E 3 medium quartz spectrograph, and was found to be proportional to the amount of nitric oxide added. The correlation of the measured intensity of the continuum with the calculated oxygen atom concentrations for a series of flames, when 0.4 per cent of nitric oxide was added to the inner flame supply, is shown in Fig. 1.

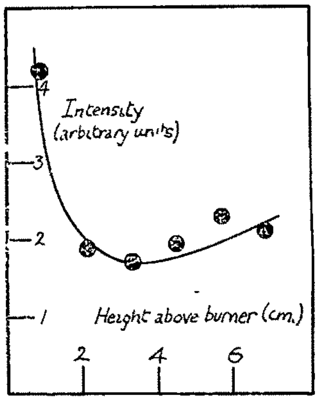


Fig 2 Variation of intensity of nitric oxide continuum with height above burner

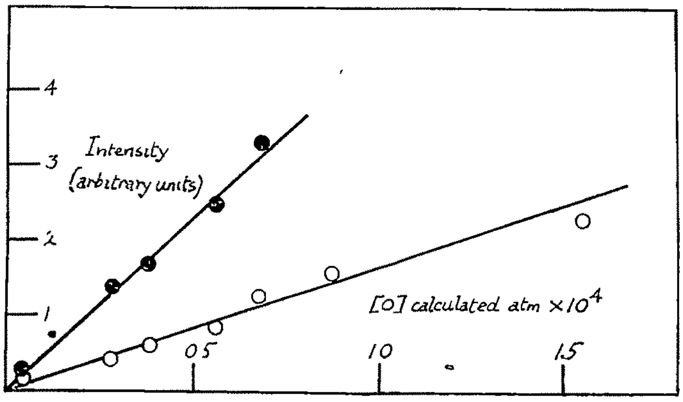


Fig 1 Intensity of nitric oxide continuum against calculated equilibrium [O] for various flames of hydrogen, oxygen and nitrogen ● = 0.8 cm above burner, ○ = 3.2 cm above burner

The upper line was obtained just above the primary cones (0.8 cm above the burner), and the lower line well into the interconal gases (3.2 cm. above the burner). Both show a quite good linear relation with the calculated oxygen atoms. This variation in intensity at different levels in the flame is shown in a particular case in Fig 2, indicating a very rapid decrease in the first centimetre or so above the primary cones, followed by a gradual rise. The intensity of the sodium D lines remained sensibly constant over the total range of height, indicating reasonable constancy of temperature of the bulk of the gases.

It is suggested that there is an excess of free atoms of oxygen over the equilibrium value immediately above the cones, which rapidly approaches equilibrium The time taken for the gas to travel through 1 cm is of the order of 1 m sec The further slow rise is attributed to the effects of indrawn air causing secondary combustion.

It is interesting to note from Fig. 1 that even where the excess occurs it is proportional to the equilibrium amount, that is, it is still governed by the concentrations of the major constituents of the burned gases, which are at or near equilibrium throughout at the reversal temperature These results, as well as confirming the views of Gaydon, show that in these flames, where dissociation of nitric oxide to nitrogen and oxygen is not important, certain quantitative applications are possible

We are grateful to Mr. M T Sampson, of the Butterwick Research Laboratories, Imperial Chemical Industries, Ltd., for the loan of the spectrograph, and one of us (C G J) to the Department of Scientific and Industrial Research for a maintenance allowance

C G. JAMES
T. M. SUGDEN

Department of Physical Chemistry,
University of Cambridge
Sept. 24

---

[1] Gaydon, A G , *Proc Roy Soc* , A, 183, 111 (1944)

[2] Gaydon, A G , *Trans Farad Soc* , 42 292 (1946)

[3] Gaydon, A G , and Wolfhard, H G , "Flames their Structure, Radiation and Temperature", Chap 10 (Chapman and Hall, London, 1953)

[4] Lewis, B , and von Elbe, G , "Combustion, Flames and Explosions of Gases", appendix *A* (Academic Press, Inc , New York, 1951)

Comparison of the Spectra produced by Shock Waves, Flames and Detonations

IT is now well known that intense shock waves can be produced by bursting diaphragms[1] and that very high temperatures, up to perhaps 20,000° K , can be attained in this way[2] The temperature rise occurs in a very short time, corresponding to only about twenty intermolecular collisions Kantrowitz and colleagues have focused attention on the value of work with shock waves and shown that in some cases they may be sufficiently intense to cause emission of light[3] The highest temperatures are attained with monatomic gases, with polyatomic gases the higher specific heat and especially the dissociation of the gas limits the temperature. Some preliminary studies of the spectra excited in rare gases have been made[4] and recently Greene[5] has observed emission bands of C_2, CH and CN when passing shocks through CF_3I, CH_3I or BrCN

We have commenced to apply the shock-wave technique to the study of combustion problems. Shock waves offer the possibility of simulating the conditions occurring in the reaction zone of a flame, where reactants are brought very quickly to a high temperature With shock waves we have the added possibility of studying the effect of this quick heating in the absence of an oxidizer. Spectroscopic studies of shock waves through fuels may supplement direct flame spectra and studies of flash photolysis Detonations in closed-vessel explosions are, of course, accompanied by a shock wave, and these studies of shock waves alone may help to elucidate the respective shares of shocks and combustion processes in producing luminosity

We have used a shock tube of the normal bursting-diaphragm pattern. The high-pressure chamber is 18 in. long and 2 in. in diameter and is made of $\frac{1}{8}$ in brass It is bolted by flanges to the low-pressure side, which is 46 in long, 2 in. diameter and of $\frac{1}{16}$ in brass The inside is copper-plated, and the low-pressure side is lined with a 'Pyrex' tube cleaned with dilute hydrofluoric acid , this was to reduce impurities, the spectra of which were very troublesome and which appear to be one of the main limitations of the method. The tube was mounted vertically, so that the wave travelled upwards and fragments of diaphragm fell down to the bottom The light was viewed end-on through a thick quartz window, an aluminium mirror being used to reflect the light into a small *F*/4 Hilger Raman spectrograph with interchangeable glass and quartz optics

Hydrogen was used as the driver gas on the high-pressure side, a single diaphragm of 0 003 in cellulose acetate bursting at about 3 atm , and a double diaphragm at 6 atm. The low-pressure side was filled with the experimental gas to a pressure of the order 1 cm mercury For hydrocarbons the initial shock wave may have a Mach number of about 6, and after reflexion a temperature rather greater than 2,000° K is expected

In the work with pure fuel gases, we have found that acetylene gives quite a bright flash, the spectrum showing mainly a strong continuum due to hot carbon particles with some weak C_2 bands and impurity lines (sodium, calcium, copper) superposed. The spectrum from ethyl nitrate showed strong CN violet bands. These are the only two pure fuels which gave a bright enough flash for the spectrum to be recorded. Ethylene gave a weak flash No flash at all was observed with methane or methanol We have therefore studied the flashes produced in mixtures of fuel and argon, this giving more intense hotter shocks Pure argon showed numerous strong lines due to impurities (silver, barium, calcium, copper, iron, magnesium, sodium, silicon, vanadium) with the OH band and some background continuum With a mixture of 90 per cent argon and 10 per cent methane, these impurities were largely suppressed and the spectrum showed very strong C_2 Swan bands on a background continuum extending from the red limit of the plates to at least 3900 A (the limit of the glass optics) The CH band at 4315 A was visible although not strong Acetylene/argon gave a similar spectrum but with rather stronger continuum, which extended to about 2600 A., this continuum was relatively less strong when the pressure of the acetylene/argon mixture was reduced to a few millimetres. Argon/carbon dioxide mixtures failed to give any obvious sign of the carbon monoxide flame bands or blue continuum characteristic of the carbon monoxide flame, the spectrum being dominated by impurities and being similar to that with pure argon, but weaker This supports other work indicating that the carbon monoxide flame radiation is chemiluminescent in origin and not due to thermal radiation from carbon dioxide

Shock waves from bursting diaphragms can also cause ignition in explosive mixtures, and the shock tube has been used for comparing the spectra of shock-ignited and spark-ignited explosions of similar mixtures For spark ignition a small side tube with electrodes connected to an induction coil was added For acetylene/oxygen and ethylene/oxygen mixtures, there was a marked difference between the shock ignition and the spark ignition. With spark ignition the CH bands at 4315 and 3900 A. were relatively much stronger than with shock ignition, whereas the HCO and especially the OH bands were much stronger with shock ignition In all plates with spark ignition, CH 4315 A was the strongest feature on the plate, whereas with shock ignition OH 3064 A was the strongest feature With shock ignition the (2,0) and (1,0) OH bands were also quite strong, but with spark ignition the (1,0) only appeared faintly and (2,0) was not observed The spectrum of the spark-ignited explosions was similar to that of steadily burning flames of similar mixtures, but some impurity lines were observed in the explosions, these being relatively strengthened by raising the pressure The strength of OH and the weakness of CH in the shock-ignited explosions suggest a greater thermal excitation by the shock wave, and perhaps some change in combustion mechanism.

The study of spectra produced by shock waves appears to be a promising way of attacking certain combustion problems, in particular the mode of formation and excitation of radicals such as C_2, CH and OH.

A. R. FAIRBAIRN
A G. GAYDON

Chemical Engineering Department,
Imperial College,
London, S W.7.
Dec. 22.

[1] Payman, W, and Shepherd, W C F, *Proc Roy Soc*, A, 186, 293 (1946)

[2] Resler, E L, Lin, S C, and Kantrowitz, A, *J App Phys*, 23, 1390 (1952)

[3] Perry, R W, and Kantrowitz, A, *J App Phys*, 22, 878 (1951)

[4] Hollyer, R N, Hunting, A C, Laporte, O, and Turner, E B, *Nature*, 171, 395 (1953)

[5] Greene, E F, *J Amer Chem Soc*, 76, 2127 (1954)

Laboratory Production of the Vegard – Kaplan Bands

THE Vegard – Kaplan $A^3\Sigma - X^1\Sigma$ bands of nitrogen (N_2), some members of which are thought to occur in the spectrum of the upper air, usually require rather special conditions for production in the laboratory[1] Wulf and Melvin[2] and Janin[3] have, however, shown that they are emitted readily from discharges through pure nitrogen in conventional ozonizers As such tubes are somewhat inconvenient to set up and outgas, we have sought to modify them and have found the simple form shown diagrammatically in Fig 1 quite effective. The left-hand section is a piece of 'Pyrex' tube, connected to a pumping train and sodium azide nitrogen generator through a trap cooled in liquid oxygen The central section consists of the same tube flattened to a roughly circular disk 7 cm in diameter, with its plane normal to the paper, and an internal clearance of 2–6 mm. The right-hand section is a 'Pyrex'-quartz graded seal with a flat quartz end. A Tesla discharge is passed through the central section between disk electrodes (A,A') pressed against its outer faces, and the spectrum observed through the quartz window. The discharge is a shower of small sparks, as described by Wulf and Melvin

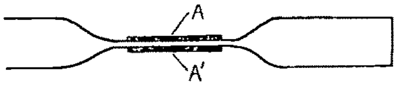


Fig 1 Narrow section of simple discharge tube for excitation of Vegard – Kaplan bands

Like previous workers, we have not found it possible to eliminate completely the γ-bands of NO and the 2537 A. line of mercury. The main ultra-violet Vegard – Kaplan bands were obtained from this source at pressures of 7 cm mercury upward Their intensity was highest at about atmospheric pressure, and showed no appreciable variation between 76 and 160 cm mercury, the latter being the highest pressure used

We have also found that these ultra-violet Vegard – Kaplan bands can be produced (*a*) from Tesla discharges in nitrogen in cylindrical quartz tubes of up to 5 cm. diameter, in this case, although less intense at the highest pressures than with the flat tube, they could be detected at a pressure as low as 1 cm. mercury, (*b*) from discharges through nitrogen in tubes of the form used by Jenkins *et al.*[4], and by others[5], to produce the 'forbidden' green line of oxygen. This has not, however, proved to be a good source and we have not succeeded in finding if, like the green line, they are here emitted preferentially from the periphery of the discharges or an afterglow

None of our plates shows the Vegard – Kaplan bands in the visible region which have been reported from electron-beam discharges through argon and nitrogen[6].

N. D. SAYERS
G. R. TAYLOR
K G EMELEUS

Physics Department,
The Queen's University,
Belfast
Oct 14.

[1] Pearse, R W B, and Gaydon A C, "Identification of Molecular Spectra" (Chapman and Hall, London, 1950) Herman, R, and Herman, L, *J Phys*, 10, 132 (1949)

[2] Wulf, O R, and Melvin, E, *Phys Rev*, 55, 687 (1939)

[3] Janin, J, Thesis, Paris (1946)

[4] Jenkins, H G, Bowtell, J N, and Strong, R W, *Nature*, 163, 401 (1949)

[5] Emeléus, K G, Sayers, N D, and Bailey, R A, *Nature*, 166, 656 (1950) Sayers, N D, and Emeléus, K G, *Proc Phys Soc*, 65 A, 219 (1952)

[6] Bernard, R, *C R Acad Sci*, *Paris*, 200, 2074 (1935)

Measurement of the Doppler Width of the λ 5577 Line in the Night Sky

A DETERMINATION of the Doppler width of the λ 5577 oxygen line in the night sky spectrum was attempted by Babcock[1], but his instrumentation permitted only an estimate of the upper limit of this width and hence of the temperature of the emitting layer. We wish to report here preliminary results of a new study of the λ 5577 line using improved interferometric apparatus.

A Fabry–Perot interferometer of 45 mm aperture was placed in front of an $f/2$ 5 photographic objective of 7 in. focal length The entire instrument, including the photographic plate, was in an air-tight enclosure with carefully controlled temperature An Eastman 103*a*-*G* photographic plate and a Corning No. *GG*-7 filter were used.

The interferometer plates were coated with multilayer dielectric films Initially, the films consisted of nine layers, of which five were zinc sulphide and four were cryolite, and which gave a reflectance at λ 5577 of 98 per cent. With these films the peak transmittance of the interferometer was very low, the cause of this was ultimately traced to the fact that the plates were flat to within only about λ/20 According to a theory given by Chabbal[2], films of lower reflectance would give higher peak transmittance with no substantial loss of resolving power A five-layer film giving a reflectance of 87 per cent proved satisfactory and gave good photographs with 5 hr exposure to the night sky, whereas an exposure of 22 hr with the nine-layer films was insufficient

The observational procedure consisted of the following steps (1) The interferometer was adjusted visually using the λ 5461 line from a low-pressure mercury arc (2) A photograph was taken of the fringes formed with the λ 5461 line from a mercury-198 lamp (3) With the photographic plate moved to a second position, an exposure to the night sky was made On the same photograph was included

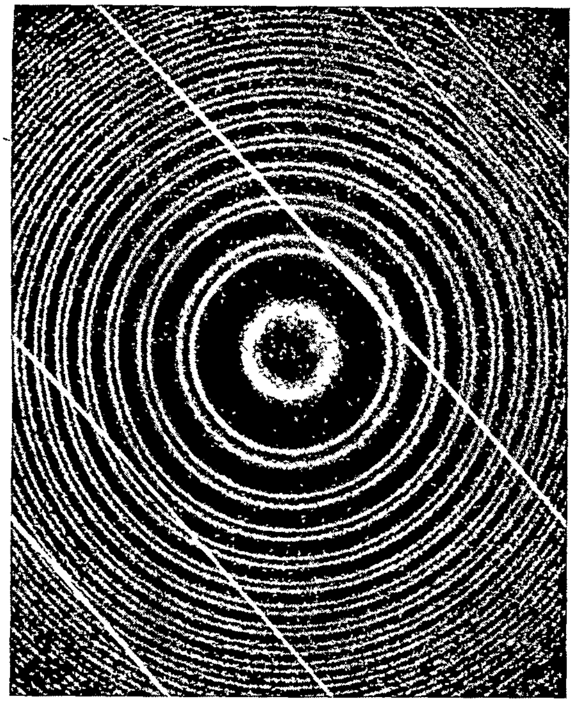


Fig 1 Photograph of interference fringes of λ 5577 of the night sky and of λ 5461 of mercury-198 The central fringe is of λ 5577 and the pairs of fringes are successively λ 5461 and λ 5577 going outward The bright streaks are star trails

a set of fringes from the mercury-198 lamp formed by a series of several short exposures made during the course of the exposure to the night sky (4) With the photographic plate moved to a third position, step 2 was repeated. The photographs made in steps 2 and 4 were compared to check the constancy of the adjustment of the interferometer

Fig 1 shows an example of the photographs obtained in step 3 with an interferometer spacer of 11 7 mm Of each closely spaced pair of fringes in this photograph the inner one is due to mercury-198 and the outer one to λ 5577 from the night sky. Bright streaks in the figure are star trails Fig 2 shows an intensity curve derived from a microphotometer trace made along a diameter of the fringe system of Fig 1 The advantage of having the mercury-198 fringes on the same photograph as the λ 5577 fringes is that by using the intrinsic width of the mercury-198 line as determined in separate experiments (we are indebted to Prof. F A Jenkins for the measurement of the width of the λ 5461 line from the mercury-198 lamp), it is possible to determine the instrumental width of the interferometer under conditions prevailing at the time of the exposure to the night sky.

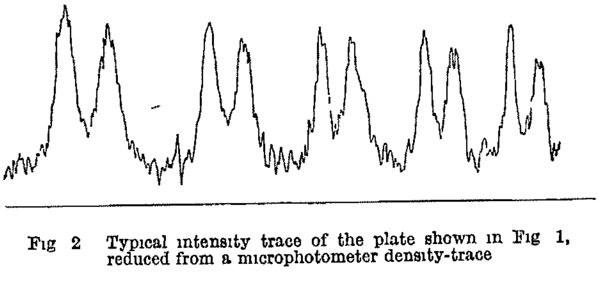


Fig 2 Typical intensity trace of the plate shown in Fig 1, reduced from a microphotometer density-trace

Doppler widths of λ 5577 were deduced from microphotometer traces under the following two separate sets of assumptions that the instrumental profile for a perfectly monochromatic line is (1) Gaussian or (2) resonance shape. Under assumption (1), the square of the half-width of the observed profile is the sum of the squares of the half-width of the instrumental contour and the half-width of the Doppler contour, while under assumption (2) the method of Voigt parameters[2] must be used

Our preliminary results under assumption (1) indicate a Doppler width at half-maximum intensity of 0 0148 A, which corresponds to a temperature of 231° K. Under assumption (2) we find a Doppler width of 0 0125 A, corresponding to a temperature of 155° K An examination of the intensity profile of the λ 5577 line as given by the interferometer indicates a condition intermediate between assumptions (1) and (2)

According to the latest published work[4], the height of the layer emitting λ 5577 is about 250 km At this altitude the temperature would be expected to be much higher than our results indicate However, more recent unpublished work (Roach, private communication) gives about 100 km for the height of the layer At the latter height the temperature is believed to be about what we find

We plan to continue this work after making improvements in our apparatus

We thank Prof John G Phillips, Berkeley Astronomical Department, for suggesting this problem and for his valuable discussions, Prof. F A Jenkins, Department of Physics, for many helpful suggestions, and Dr C D Shane, director of the Lick Observatory, for providing facilities for making the observations

DAVID Q WARK

Berkeley Astronomical Department,
University of California,
Berkeley.

JOHN M. STONE

Department of Physics,
University of California,
Berkeley

---

[1] Babcock, H D, *Astrophys J*, 57, 209 (1923)

[2] Chabbal, R, *J Recherches du Centre Nat Recherches Sci*, No 24, 138 (1953)

[3] van de Hulst, H C, and Reesinck, J J M, *Astrophys J*, 106, 121 (1947)

[4] Roach, F E, and Pettit, H B, *J Geophys Research*, 56, 325 (1951)

Melting Points of Mono-*N*-*n*-alkylaniline Hydrochlorides

IN the course of other work, we have had occasion to prepare the series of liquid mono-*N*-*n*-alkylanilines ($C_6H_5NHC_mH_{2m+1}$) from $m = 1$ to $m = 12$ We have determined their refractive indices and also the melting points of their hydrochlorides[1]. A plot of refractive index against alkyl chain-length for the free bases gives a smooth curve characteristic of all homologous series in respect of physical properties The melting point against chain-length curve for the solid hydrochlorides is, however, very different. A large drop in melting point on passing from aniline to monomethylaniline hydrochloride is followed by a marked zig-zag to a minimum at $m = 6$, thence the melting points rise steadily with a small but definite alternation

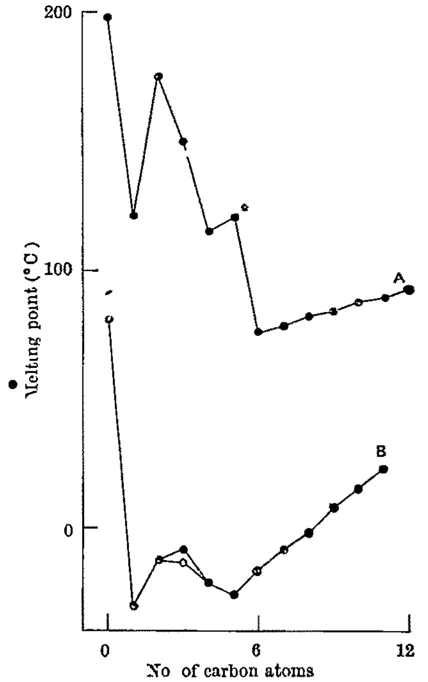


Fig 1 Curves of melting point against alkyl chain-length for (*A*) *N*-*n*-alkylaniline hydrochlorides , (*B*) α-*n*-alkylnaphthalenes

* The melting point of *N*-*n*-pentylaniline hydrochloride has been found to be 120°, in agreement with v Braun and Murjahn (ref 4), and not as previously quoted bv us (ref 1)

This kind of behaviour can be paralleled from other homologous series. Thus Anderson and Smith[2] find a very similar effect in the α-*n*-alkylnaphthalenes, with a minimum melting point at $m = 5$, followed by an alternating rise. This alternating rise is characteristic of predominantly aliphatic series and recalls in particular the rising periodicity in the melting points of the aliphatic acids[3], and appears to indicate that at about $m = 5$ or 6 aliphatic character begins to predominate in the alkyl–aryl series

R Foster
D Ll Hammick

Dyson Perrins Laboratory,
University, Oxford

Oct 16

[1] Foster, R , and Hammick, D Ll , *J Chem Soc*, 2685 (1954)
[2] Anderson, D G , and Smith, J C , *J Inst Petrol*, 38, 415 (1952)
[3] Piper, S H , *J Chem Soc*, 234 (1929)
[4] v Braun J , and Murjahn, R , *Ber deutsch chem Ges*, 59, 1205 (1926)

Chemical Composition of the Melanin Granule and its Relation to the Mitochondrion

It has been suggested that the melanin-containing granules of melanocytes are derived from the mitochondria of these cells The term 'melanized mitochondria' has been used for describing the melanin granules[1] The main evidence to support this contention has been the demonstration of the presence in both mitochondria and melanin granules of the enzymes succinic dehydrogenase and cytochrome oxidase.

Some information is available as to the chemical composition of certain mitochondria[2,3]. It was felt desirable to obtain comparable information for the melanin granule.

Melanin granules were isolated from the choroid of ox eye by differential centrifugation at 0–4° C. Use was made of the high density of the melanin granules in order to obtain them in a relatively pure preparation Using a Waring blendor, the dissected-out choroids were homogenized in four times their volume of chilled physiological saline The tissue was further disintegrated by grinding with sand in a mortar. Much of the cell debris was removed by two centrifugations at 600 *g* for 3 min The granules were then sedimented by centrifugation for 30 min at 600 *g*. The sediment, on microscopical examinations of smears stained with methylene blue, showed the presence of a small amount of cell debris contaminating the preparation The sediment was then homogenized in 1 55 *M* sucrose (spec. grav. = 1 2) using a Potter–Elvehjem type homogenizer. The granules were sedimented from this homogenate by centrifugation at 1,000 *g* for one hour The centrifugation in the sucrose medium effectively separated the dense melanin granules from the contaminating lighter cell constituents. The sedimented granules were washed twice with distilled water and the washings kept for analysis

The lipid, ribose nucleic acid, soluble and insoluble protein and the iron, copper, zinc and melanin pigment content of the granule preparation were determined on a dry-weight basis

Lipid was estimated by extraction in 3 . 1 chloroform/methanol for 24 hr. at 25° C , followed by re-extraction of the granules in a Soxhlet apparatus for 12 hr , using the same solvent. The combined solvent was dried at 80–90° C for 24 hr. and the residue weighed Ribose nucleic acid was extracted by the Schmidt–Tannhauser–Schneider procedure and determined as pentose, using orcinol against a xylose standard Soluble protein was estimated as nitrogen in the distilled water washings of the granule. The washings gave a negative test for ribose nucleic acid. Insoluble protein was determined by a formol titration of the amino-acids liberated by hydrolysis of the melanin granule in boiling *M* potassium hydroxide for 12 hr. Melanin pigment was precipitated on acidification of the alkaline hydrolysate of the granule The pigment was purified by repeated solution in alkali and precipitation with acid[4]. The final precipitate was washed three times with distilled water, dried and weighed The granules were ashed to constant weight Copper and zinc in the ash were estimated as their dithizone complexes in carbon tetrachloride[5] Iron was determined as ferric thiocyanate in amyl alcohol. Most of the above determinations were performed, also, on a homogenate of choroid tissue.

Table 1 gives the analytical data for the melanin granule preparation and for the homogenate of

Table 1

Component	Melanin granule (per cent)	Choroid tissue (per cent)	Mito-chondrion (per cent)	References
Melanin pigment	35–40	5–6		
Lipid	1–5	9–13	25–30	(2, 3)
Ribose nucleic acid	Less than 0 3	1 3–1 7	0 8–1 6	(6)
Soluble protein	15–20	—	63	(2)
Insoluble protein	10–15	—		
Carbohydrate	5–10	—	—	
Ash	4–6	—	—	
	(µgm /gm)	(µgm /gm)	(µgm /gm)	
Copper	25–55	6–8	—	
Iron	800–950	200–300	200–400	(6)
Zinc	550–900	130–150	—	

choroid tissue. Comparable data on the mitochondrion are collated from various authors. The values given are extreme ranges found for several determinations. Melanin granule data are corrected for the presence of contaminating sand.

Not accounted for in the above analysis was some 15 per cent of the granule. This fraction appeared to have a nitrogen content of 15–20 per cent. It contained an acid-soluble red-brown pigment and, possibly, difficultly hydrolysable protein. The high nitrogen content suggests that the fraction not accounted for contained little lipid. It would appear that all or most of the lipid of the granule had been estimated by the initial extraction procedure.

For every constituent, there is a great difference between the compositions of the melanin granule and the mitochondrion. Especially significant is the low lipid and content of ribonucleic acid of the melanin granule in contrast to the high content of these constituents in the mitochondrion. The high copper, zinc and iron content of the melanin granule is particularly noteworthy. Most of, if not all, these mineral constituents appear to be localized in the melanin granule.

The above results do not support the view that the mitochondrion is converted into a melanin granule by a simple process of 'melanization'. If a conversion does occur it would appear to involve a drastic reorganization of the cell contents. It seems desirable to regard the melanocyte as a whole as being involved in the formation of the melanin granule, rather than the granule in isolation.

A further report of the above findings and their bearing on the problem of melanogenesis will, it is hoped, be published elsewhere.

I wish to thank Prof. Joseph Gillman for his invaluable advice and encouragement.

W. D. STEIN

Department of Physiology,
and Joint Nutrition Research Unit of the
Council for Scientific and Industrial Research,
and the University of the Witwatersrand,
Medical School, Johannesburg.

Sept. 10.

---

[1] Du Buy, H. G., Woods, M. W., and Showacre, J. C., in "Pigment Cell Growth", 335 (Academic Press, New York, 1953).

[2] Swanson, M. A., and Artom, C., *J. Biol. Chem.*, 187, 281 (1950).

[3] Barnum, C. P., and Huseby, R. A., *Arch. Biochem.*, 19, 17 (1948).

[4] Stein, W. D., *Nature*, [174, 601 (1954)].

[5] Bowness, J. M., Morton, R. A., Shakir, M. H., and Stubbs, A. L., *Biochem. J.*, 51, 521 (1952).

[6] Davidson, J. N., "The Biochemistry of the Nucleic Acids", 75 (Methuen and Co., London, 1950).

Production of Cancer of the Bile Ducts with Thioacetamide

DURING the past ten months, I have been feeding rats on thioacetamide with the object of studying chronic intoxication induced by that compound. 1 gm. of thioacetamide was dissolved in 60 ml. absolute alcohol, thoroughly mixed with 3,125 gm. of M.R.C. powdered rat cubes, and the alcohol evaporated off. One hundred and fifty rats received unlimited amounts of this mixture; fifty had the control diet consisting of powdered cubes mixed with absolute alcohol in the same ratio as in the experimental mixture. Groups of animals were killed at regular intervals from each batch for a careful study of the liver pathology.

The earliest changes of necrosis and monocellular infiltration soon gave place to proliferation of the bile ducts and regeneration of the liver cells. After feeding for eleven weeks with thioacetamide, localized areas of cholangiofibrosis—a term used by Opie[1] in his study of butter yellow (*p*-dimethylaminoazobenzene) tumour formation—appeared and increased progressively until at nineteen weeks they formed large nodules indistinguishable from cancer of the bile duct. Less frequently, collections of cystic bile ducts also developed, but neither hepatomas nor metastases have so far been encountered. These pathological changes recall those met with in rats fed with butter yellow[2], and they likewise develop in the same sequence. Of the 150 rats exposed to thioacetamide, about fifty died before the ninth week from destruction of the liver; of the thirty-six animals killed between nine and twenty-three weeks, twenty-two showed cholangiofibrosis, eighteen bile duct cancers and five cystic dilatation of bile ducts. Several conditions are, of course, not infrequently found in the same animal. Feeding is still going on in the remaining sixty rats. No such changes were found in the control rats. Under these conditions, therefore, it appears that thioacetamide is a powerful cause of bile duct proliferation which culminates frequently in cancer.

Fitzhugh and Nelson[3] described liver cirrhosis in rats fed with thioacetamide and mentioned tumours in two of fifty rats, one said to be a liver cell adenoma, the other a "histologically malignant tumour originating from liver cells". A more detailed study by Rather and his co-workers[4] emphasizes gradually developing diffuse fibrosis, nodularity of the liver and increase in weight of that organ. Apparently no tumours were discovered. Taki *et al.*[5] describe experiments in which groups of rats were fed butter yellow alone, thioacetamide for six to eight weeks followed by butter yellow, and thioacetamide and butter yellow together. No tumours developed; but the duration of these experiments was rather short and details presented are scanty.

Thioacetamide was introduced by Childs and Siegler[6] in 1945 as a medium for the control of orange decays. It is known to penetrate to the juice of the orange, and must therefore be considered as a possible risk to consumers of oranges. I must emphasize that the carcinogenic effects in rats have been obtained only after prolonged feeding, although the quantity of thioacetamide consumed by a rat each day cannot have been more than a few milligrams.

The investigation, which was suggested by Prof. G. R. Cameron, is still going on and full details will be published in due course.

D. N. GUPTA

Department of Morbid Anatomy,
University College Hospital Medical School,
London, W.C.1.

Dec. 17.

---

[1] Opie, E. L., *J. Exp. Med.*, 80, 231 (1944).

[2] Kinosita, R., *Trans. Soc. Path. Jap.*, 27, 665 (1937). Orr, J. W., *J. Path. Bact.*, 50, 393 (1940). Cheng, K. K., *J. Path. Bact.*, 61, 23 (1949).

[3] Fitzhugh, O. G., and Nelson, A. A., *Science*, 108, 626 (1948).

[4] Ambrose, A. M., De Eds, F., and Rather, L. J., *J. Indust. Hyg. Tox.*, 31, 158 (1949). Rather, L. J., *Bull. Johns Hopkins Hosp.*, 88, 35 (1951).

[5] Taki, I., Kawai, K., Uemura, F., Kitamura, H., and Sayama, Y., *Gann*, 43, 116 (1952).

[6] Childs, J. F. L., and Siegler, E. A., *Science*, 102, 68 (1945).

Urinary Excretion of a Substance after a Single Dose

AFTER a single dose of a substance, its urinary excretion is commonly highest during the subsequent twenty-four hours, and then decreases with time. It is often desirable to compare different urinary excretion-rates, to extrapolate or interpolate, etc., so that any method of plotting the data such that the relationship is linear between some functions of urinary excretion and time has obvious advantages.

During some work on the metabolism of radioactive phosphorus after oral administration of a single dose, we have found that the cumulative excretion of phosphorus-32 is linearly related to the logarithm of the time. Line *A* of Fig. 1 is a typical example of our findings.

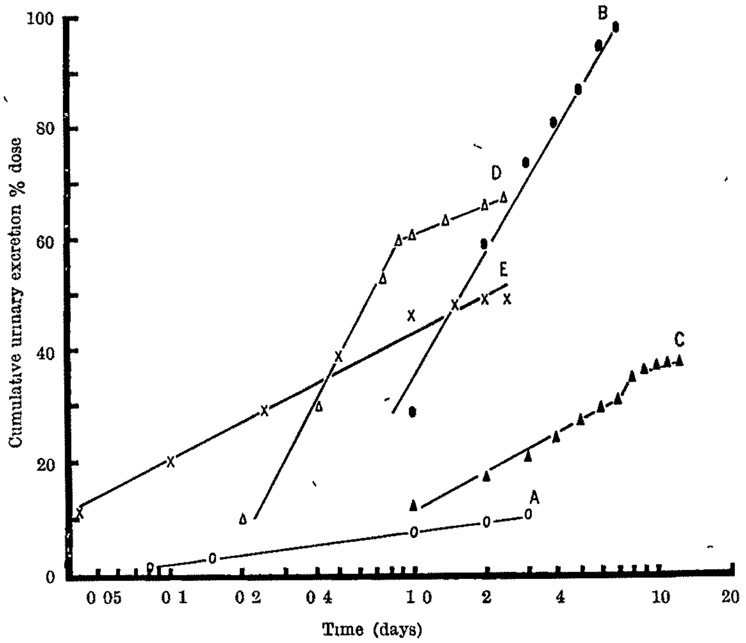


Fig. 1

This linear relationship appears to be a general one. Thus, line *B* is derived from some results reported by Van Der Werff[1], after the subcutaneous injection of bismuth-206 in the form of bismuth citrate. Line *C* shows another set of results re-plotted from the same paper, this time when the bismuth was mixed with a charcoal suspension and given by intravenous injection. This line shows a discontinuity, which may possibly be due to instability of the bismuth–charcoal suspension.

Wilkinson and Storey[2] have published some cumulative urinary excretion figures for polyvidone, a plasma substitute which is not metabolized. Line *D* shows the results from one of their cases, when plotted on a logarithmic time-scale. This line shows an abrupt change in slope which was not obvious when the data were plotted on a linear time-scale.

We have found this linear relationship very useful in our work on phosphorus-32, and we have expressed the slope of the line as the 'double time factor'. This is defined as the quantity *Q* excreted in the urine, such that if a quantity x is excreted in time t, a quantity $x + Q$ is excreted in time $2t$. It is numerically equal to the quantity excreted during the second day. It can be shown that

$$x \log 2 = Q \log \frac{t}{t_0}, \qquad (1)$$

where t_0 is the intercept of the line on the time axis. Differentiating, we have

$$\frac{dx}{dt} = 1·44 \frac{Q}{t}. \qquad (2)$$

Thus, the urinary excretion-rates may be expressed in terms of one parameter, the double time factor.

This method of plotting the urinary excretion has the further advantage that, where there are any discontinuities, these become obvious and precisely located in time.

It is not, however, the only possible way of endeavouring to fit cumulative excretion figures to an equation. For example, Haigh and Reiss[3] quote the relationship

$$x = x_{\max}\{1 - \exp(-\lambda t)\}, \qquad (3)$$

where λ defines the rate at which excretion proceeds, and $x_{\max}$ is the cumulative urinary excretion when this is complete. Their figures for the cumulative urinary excretion of iodine-131, when plotted on a logarithmic time-scale, give the line *E* of Fig. 1.

Equations (1) and (3) are not mutually consistent, and a particular set of results may prove to be a more or less good fit for either. The form of equation (3) is more logically explained than that of equation (1), but in a few cases tested by both equations, in general, it did not lead to better fits. Equation (1) has the advantages that it is very simple to apply, and that its use does not necessitate an estimate of the value of $x_{\max}$ which appears in equation (3), and which may be unknown. On the other hand, equation (1) is a divergent function of x, and in some cases, for example line *B*, obviously cannot hold when t becomes large.

Acknowledgments are due to the British Empire Cancer Campaign for financial assistance.

BABETTE E. STERN

Marie Curie Hospital,
London, N.W.3.
Sept. 2

---

[1] Van Der Werff, J. T., "Bismuth-206: A New Radioactive Isotope for Therapy" Second Radioisotope Conference, Oxford (Butterworths Scientific Publications, London, 1954).

[2] Wilkinson, A. W., and Storey, I. D. E., *Lancet*, i, 1269 (1954).

[3] Haigh, C. P., and Reiss, M., *Brit. J. Radiol.*, 23, 538 (1950).

Action of Ribonuclease on Certain Ascites Tumours

PREVIOUS papers[1] have described the action of ribonuclease on the cells of the Ehrlich carcinoma *in vitro*, and the object of the present communication is briefly to record results obtained *in vivo*, following the administration of ribonuclease to animals bearing various ascites tumours. These experiments involved three hundred animals carrying the Ehrlich or Krebs mouse carcinomata, or the Walker rat carcinoma 256.

The mean survival-time of the experimental animals was determined in relation to the number of injected

Table 1

Tumour (ascites)	Times of injection (days after implantation)	Nature of injection	Controls Mean survival-time	Controls No	Treated Mean survival-time	Treated No	P	Mean prolongation of survival-time (per cent)
Ehrlich carc	2	20 mgm ribonuclease	6 4	(25)	7 8	(25)	<0 01	22
,,	2, 3	10 mgm ribonuclease	6 5	(10)	8 8	(10)	<0 01	36
,,	5, 5	8 mgm ribonuclease + 0 1 mgm nucleot	8 6	(15)	9 8	(15)	<0 05	15
,,	7, 8	2 mgm ribonuclease† + 0 1 mgm nucleot	8 3	(10)	23 5	(10)	<0 01	183
,,	4, 8, 11, 13	1 mgm ribonuclease† + 0 1 mgm nucleot	12 5	(20)	16 5	(20)	0 05	32
Krebs carc	4, 5	2 mgm ribonuclease† + 0 1 mgm nucleot	5 3	(10)	8 2	(10)	<0 05	54
Walker carc	2, 3, 4, 5	5 mgm ribonuclease + 5 mgm nucleot	6 5	(10)	10‡	(9)	<0 05	54

† Ribonuclease purified by chromatography fraction D (ref 3)
‡ Excluding one animal in which the tumour regressed

cells. Confirming the results obtained by Goldberg *et al.*[2], the curve giving the relation between the number of cells injected and the mean survival-time shows three distinct parts The first corresponds to inocula very rich in cells, when the mean survival time does not vary significantly if the number of cells inoculated is more than 1 million The second part of the curve shows that below this limit the mean survival-time varies in proportion to the density of the inoculum Finally, a third section, corresponding to the development of solid tumours, extends towards high survival-times and is limited by the minimum number of cells, of the order of 10,000, necessary for transplantation In the present experiments, doses of between three and thirty million cells were used Treatment began at least two days after implantation Equal numbers of control and treated animals were used in each experiment, and the results were examined statistically The enzyme was administered intraperitoneally by a single or daily injection (the latter being the more effective), or by injection at intervals of several days, and two kinds of ribonuclease preparation were employed (1) Armour's 'RNase' purified by chromatography, the largest and most important fraction was used (peak D)[3], (2) commercial Armour's 'RNase' The sample employed contained 25 per cent of non-protein material of low molecular weight and 75 per cent of material homogeneous in the ultra-centrifuge but separable by chromatography into inactive ribonuclease (10 per cent), partially active ribonuclease (25 per cent), fully active ribonuclease (60 per cent) and a further 5 per cent of a protein impurity without proteolytic activity

In the majority of cases mixtures of ribonuclease and nucleotides were employed, since other work had indicated the importance of the latter for enzymatic action[1] This point will be discussed in further detail elsewhere

The ribonuclease solutions were freshly prepared and sterilized by Seitz filtration, their pH being that of the physiological saline or sterile distilled water used as a control The results (Table 1) show that the treatment induces a significant increase in mean survival-time These observations must be considered in relation to those of Klein[4], who showed that inoculation with tumour cells of which the ribonucleic acid content had been reduced by storage at 4° C was less effective than with fresh cells, it appears probable that cellular multiplication can in fact be modified through changes in the level of ribonucleic acid in proliferating cells It is also of interest to compare these results with those obtained with amphibian eggs[5], and with those of Brachet with onion roots[6]. In these cases similarly, ribonuclease diffusing across the cell membranes had a very clear anti-mitotic effect The present results appear to indicate that it is possible enzymatically to influence the ribonucleic acid and growth-rate of rapidly proliferating cells by an action possibly similar in principle to that of xanthine oxidase upon spontaneous mammary carcinomata of the mouse, as described by Haddow[7].

I wish to thank Profs A Haddow, F Bergel and P C Koller for criticisms and suggestions

L Ledoux*

Chester Beatty Research Institute,
Royal Cancer Hospital,
Fulham Road,
London, S W 3

Nov. 27.

* Chargé de recherches du Fonds National Belge de la Recherche Scientifique (Permanent address Laboratoire de Morphologie Animale, Brussels)

[1] Ledoux, L , and Baltus, E , *Experientia*, [10, 500 (1954)] *Biochim et Biophys Acta* (in the press)

[2] Goldberg, L , Klein, E , and Klein, G , *Exp Cell Research*, 1, 543 (1950)

[3] Ledoux, L , *Biochim et Biophys Acta*, 14, 267 (1954)

[4] Klein, E , Kurnick, N B , and Klein, G , *Exp Cell Research*, 1, 127 (1950) ,

[5] Ledoux, L , Le Clerc, J , and Vanderhaeghe, F , *Arch intern de Physiol* , 62, 313 (1954), *Nature*, 174, 793 (1954) , *Biochim et Biophys Acta* (in the press)

[6] Brachet, J , *Nature*, 174, 876 (1954)

[7] Haddow, A , Ann Rep Brit Emp Cancer Camp , 37 (1953)

Deoxyribose Nucleic Acid Values in Tumour Cells with Reference to the Stem-cell Theory of Tumour Growth

Recent technical developments have increased the accuracy and scope of photometric measurements of deoxyribose nucleic acid on Feulgen-stained nuclei By using the scanning photoelectric device[1,2] in conjunction with the cell-crushing method[3], it is possible to make accurate measurements not only on interphase nuclei, but also on cells in mitosis It has been shown that increase of deoxyribose nucleic acid occurs during interphase[4,5] Hence measurements of the deoxyribose nucleic acid during mitotic stages are not subject to variation due to this synthesis

A series of measurements of deoxyribose nucleic acid in cell nuclei of the Krebs's 2 and Ehrlich's mouse ascites tumours have been made and the results are shown in Figs 1 and 2 , the non-tumour inflammatory cells provide a useful marker for the diploid value of deoxyribose nucleic acid (2c) A wide spread of figures for the acid content about the octoploid value (8c) is obtained for cells at metaphase (standard deviations Krebs's ± 7 5, Ehrlich's ± 6 3) If all these cells at metaphase completed division then a similar spread would be expected for cells at telophase, which, however, show only a small scatter about the tetraploid figure (4c) (standard deviations Krebs's ± 0 42 Ehrlich's ± 0 54) Since a metaphase of 8c will normally give rise to telophases of 4c, this suggests that in this material normal division with successful cell-cleavage occurs mainly among cells which at metaphase contain approximately the 8c amount of deoxyribose nucleic acid, and which are balanced in the genetical sense The cells which at metaphase depart from the 8c value of deoxyribose nucleic acid (that is, unbalanced cells) probably arise from non-4c telophase cells produced by the occasional abnormal division of an 8c metaphase The non-8c metaphases form a large proportion of the sample, and if these cells linger at metaphase for long periods this would explain the relative scarcity of non-4c telophases (which were not detected in the present measurements) from which they may be derived. Incomplete reduplication of the chromosome complement during interphase may also be a factor in the production of non-8c metaphases The metaphase cells which do not divide probably undergo restitution or division without cell-cleavage, and as a result restitution nuclei, binucleate and multi-nucleate cells are fairly common in these tumours. Lasnitzki has arrived at similar conclusions of reconstruction from metaphase, on the basis of cytological evidence, in the *S*37 sarcoma and *T*2146 ascites tumours[6]

These observations agree with the results of other workers on which the recent stem-cell theory of tumour growth is based. According to this theory only a fraction of the cells in the population are capable of normal and regular mitosis, and tumour growth is thus due mainly to the division of these stem cells, which produce not only new stem-cells but also the rest of the population. This phenomenon has been described in ascites tumour material by Levan and Hauschka[7] and Makino and Kano[8] on the basis of chromosome counts. Accurate counts are possible only at metaphase, and the stem-cel theory was derived from the observation that a characteristic mode of chromosome numbers persisted throughout many generations of transplants The results presented here would appear to suppor the stem-cell theory of tumour growth

A similar scatter of metaphase values and a smal spread of telophase values has recently been observed in a carcinoma of the cervix uteri in man[9]. If this phenomenon is of general occurrence in human tumours, then in estimating the rate of proliferation of a tumour it is necessary to ascertain the proportion of cells at telophase in the biopsy section, as well as the total mitotic index.

The spread of deoxyribose nucleic acid values fo cells at metaphase in the Krebs's and Ehrlich's ascites tumours agrees with the histograms of chromosome numbers in the same tumours reported by Hauschka and Levan[10] This is to be expected since an accurate measurement of deoxyribose nucleic acid in a mitotic stage is related to the number of chromosomes presen in the cell, provided that the variation in deoxyribose nucleic acid content of individual chromosomes is small. The advantage of the method of deoxyribose nucleic acid measurement presented here is tha it makes possible the determination of chromosome numbers, not only at prophase and metaphase, bu also at anaphase and telophase, and under condition when visual counting methods cannot be used Thi will be discussed in a succeeding publication[11] Further investigations are being made by thi technique with special reference to immunogeneti aspects of tumour growth and will be reported elsewhere.

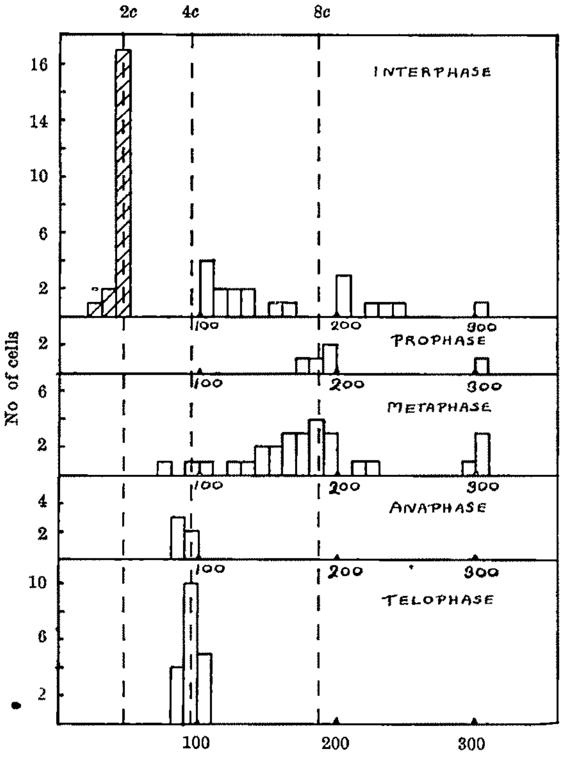


Fig 1 Krebs's ascites tumour Unshaded, tumour cells shaded, non-tumour cells

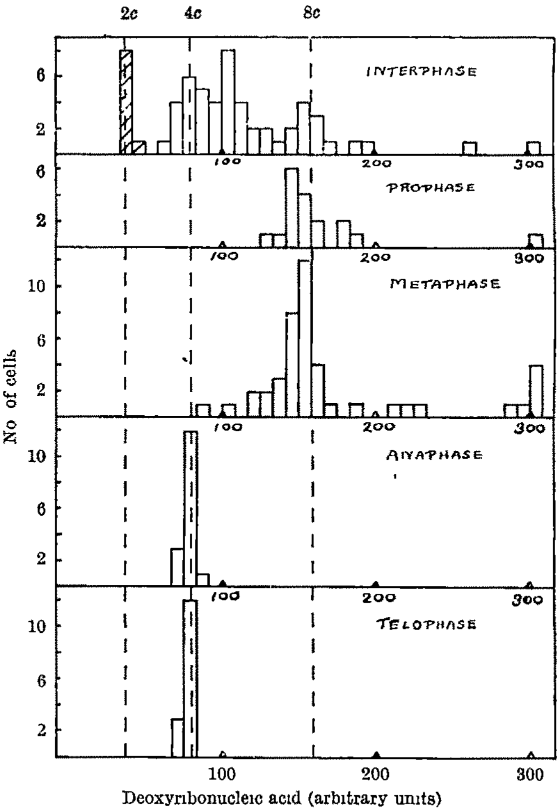


Fig 2 Ehrlich's ascites tumour Unshaded, tumour cells shaded, non-tumour cells

I am grateful to Prof J. T Randall, Dr H B Fell and Dr. P M. B. Walker for valuable advice and encouragement. My thanks are also due to Dr Ilse Lasnitzki, Dr E. M. Deeley and Dr H G Davies for discussion, and to Prof. P C. Koller and Dr. Alma Howard, who provided material. I am indebted to the Medical Research Council for the award of a scholarship which enabled this work to be done.

B M Richards

Medical Research Council
Biophysics Research Unit,
Wheatstone Physics Laboratory,
King's College, London
Oct. 22.

[1] Deeley, E M, Richards, B M, Walker, P M B, and Davies, H G, *Exp Cell Res*, **6**, 569 (1954)

[2] Deeley, E M (in the press)

[3] Davies, H G, Wilkins, M H F, and Boddy, R G H B, *Exp Cell Res*, **6**, 550 (1954)

[4] Walker, P M B, and Yates, Helen, *Proc Roy Soc*, B, **140**, 274 (1952)

[5] Swift, H H, *Physiol Zool*, **23**, 169 (1950)

[6] Lasnitzki, Ilse, *Brit J Cancer*, **7**, 238 (1953)

[7] Levan, A, and Hauschka, T S, *Hereditas* **38**, 251 (1952)

[8] Makino, S, and Kano, K, *J Nat Cancer Inst*, **13**, 1213 (1953)

[9] Richards, B M, and Atkin, N B (unpublished)

[10] Hauschka, T S, and Levan, A, *Exp Cell Res*, **4**, 457 (1953)

[11] Walker, P M B, Richards, B M, and Deeley, E M (in preparation)

Identification of Hypocalcified and Demineralized Areas in Sections of Human Enamel

Hitherto, poorly calcified areas in the enamel of ground sections of teeth have been detected either by their permeability to stains insolubility in dilute acid or by their low absorption of soft X-rays (so-called Grenz-rays) Gottlieb, Diamond and Applebaum[1] came to the conclusion that "it is impossible by means of microscopic ground section study, to differentiate between enamel in the matrix stage and fully calcified enamel". During the preparation of ground sections of teeth with obviously poorly calcified areas of enamel, we were struck by the appearance of these areas when sections were examined in water by transmitted and reflected light By transmitted light they appear opaque, while the normal enamel is translucent or transparent, by reflected light they appear white. When cleared and mounted in the routine histological manner, they become translucent, and it is often difficult to distinguish them from normal transparent or translucent enamel, but they can be distinguished from pigmented enamel by the lack of brown pigmentation Using these criteria, we were able to show, in proved cases of immature acid-insoluble enamel, almost complete agreement between the dark areas in the water-mounted sections and those observed on an X-ray negative after exposure to soft X-rays (Figs 1 and 2) The soft X-rays used were produced by a commercial type 'Raymax' tube with a tungsten target and operated at 20 kV peak and about 3 m amp emission current.

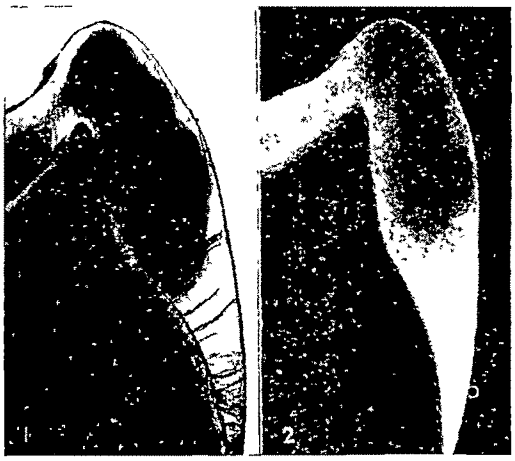


Fig 1 Ground section, mounted and photographed in water, of a grossly visible brownish opaque hypocalcified area in the cuspal enamel of a molar

Fig 2 Grenz-ray photograph of the same section

It was also found that some areas of white or brown opaque enamel, as observed on the enamel surface by reflected light and obviously poorly calcified, were soluble in acid In some cases it was difficult to obtain a clear picture of a reduced concentration of calcium salts in sections of these areas using the soft X-rays (also noted by other workers), but with the water-mounted specimens a well-defined area of opacity was always obtained. The evidence suggests that examination of ground sections in water provides a means whereby areas of poor calcification can be detected The method, however, is essentially qualitative and does not satisfactorily show differences in the degree of concentration of calcium salts The best results are obtained by studying photographic prints of the sections and, where desirable, comparing them with prints of soft X-ray negatives. It is also clear that solubility in acid is not a test for all degrees of hypocalcification

This work suggests that poorly calcified areas in the enamel may be divided into two main types, according to whether the factors retarding calcification acted before or after the critical point of maturation (that is, solubility of the enamel matrix) is reached. The first type consists of immature enamel in which the matrix is insoluble in dilute inorganic acids and is pre-critical in origin, the second type consists of soft enamel which is soluble in acids and is post-critical in origin. Post-critical hypocalcification when examined in water-mounted sections shows less, or an absence of, the yellowish appearance which is seen in immature enamel or pre-critical hypocalcification This latter is quite distinct from the brown pigmentation seen in cleared sections of normal enamel Examination of ground sections also suggested that post-critical calcification during tooth development does not proceed from the tips of the cusps or incisal edges as at the critical stage of calcification or maturation, but in an 'incremental' direction. While we are unable to differentiate in all cases, with certainty, pre-critical from post-critical hypocalcification in water-mounted sections, the distinction between hypocalcified and mature hard enamel is clearly shown

While both pre- and post-critical hypocalcified opaque areas can be seen in the gross specimen, sections of apparently normal teeth when mounted in water may show opacities which on clearing appear as either transparent or brown pigmented areas or bands along incremental layers or striæ of Retzius The brown or transparent bands which appear opaque when examined in water would seem to be hypocalcified Our findings agree with those of Thewlis[2], who found that only a certain percentage of pigmented and transparent areas gave evidence of less than normal concentration of calcium We also observed that the appearances and distribution of brown pigmented enamel were profoundly affected by clearing agents.

When ground sections of enamel showing advanced carious lesions without cavitation are examined in water and by soft X-rays, a similar correlation to that described above between the opacity in water and the area of low absorption of the X-rays exists, and suggests that the water technique may be used to identify areas of demineralization Evidence of demineralization in early carious lesions is often difficult to obtain or inconclusive using soft X-rays, but with the water technique, the opacity is consistently present

We have also noted that the early white carious lesion is soluble in acid, whereas the deeply stained brown lesion tends to be insoluble in dilute inorganic acids This appears to be due to a change in the character of the enamel protein consequent upon its permeation by material from the mouth

Thanks are due to Dr E L Yates, of the Physics Department, for his help with the soft X-ray work, and to Dr J Thewlis, of the Atomic Energy Research Establishment, Harwell, for his criticisms of the investigations I also wish to thank the Medical Research Council for an expenses grant

J J Hodson

Department of Oral Pathology,
University, Sheffield
Oct 11.

[1] Gottlieb, B, Diamond, M, and Applebaum, E, *Amer J Orthodont*, 32, 365 (1946)

[2] Thewlis, J, Spec Rep Ser, No 238, Med Res Coun (1940)

Do Tracers measure Fluxes ?

TRACERS are used extensively for the purpose of measuring the absolute flux of a substance through a membrane from, say, side A to side B in the presence of a flux from B to A Often the system is in a steady state and the two fluxes are equal, but the rate of appearance of tracer atoms (x') on side B remote from their origin (side A) is used as a measure of the flux $A \rightarrow B$, with due mathematical allowance for any back flow of x', $B \rightarrow A$.

When this technique is applied to measurement of water permeability of cell walls, the rate of movement per unit difference of concentration of isotopic water is sometimes less by a factor as high as 50 from the rate of movement resulting from a unit difference of water concentration imposed by the presence of dissolved salts[1] Frog skin shows similar anomalies[2] As a further example of anomalous rate of tracer movement, there is the fact that the flux of potassium ions through muscle cell membranes is less when found from the rate of transfer of potassium-42 than when it is deduced from the membrane conductivity on the assumption that potassium ions carry nearly all the current

The purpose of this communication is to suggest that the rate of transfer of a tracer across a membrane may bear no direct relation to the absolute flux through the membrane, this is not to imply that the tracer has any peculiar properties The explanation is of the same kind as the one recently demonstrated by Hodgkin and Keynes[4] Suppose the membrane is several times as thick as the traversing molecule (x or x') and that there can be a series of molecules (xxx) in file in a narrow pore or channel. Collision of an x' on side A can lead to formation of the file $x'xx$ with displacement of an x into the solution on side B. If the next molecular event is a collision on side B, the original xxx is restored, no tracer has passed, yet the fluxes $A \rightarrow B$ and $B \leftarrow A$ are one unit. To transfer x' to side B requires a succession of events of probability less than unity, yet each event can contribute one molecule to one or other flux Thus, when the pore is long and thin on the molecular scale, the rate of transfer of x' does not measure the flux $A \rightarrow B$. Only when the molecules in the pores can pass freely side by side, or when the membrane is so thin that a file does not exist, can one expect tracer movement to be proportional to the real flux The process when there are long pores recalls Bernal and Fowler's explanation[5] of the rapid diffusion of hydrogen ions where an ion at one end of an aqueous medium can displace one from the other end without moving there itself

In the system described, if an osmotic unbalance exists between A and B, the greater collision-rate on the high-activity side (say, B) will tend to lead to the file being filled with molecules (x) from that side, and this would reduce the rate of transfer of x' against the osmosis There could be many collisions of x' with side A which lead to ejection of an x into side B, but the probability of x' making its way into B against the net movement due to osmosis would be small Thus here an osmotic unbalance can affect the rate of diffusion of tracer, in distinction to the case in free diffusion A similar situation has been discussed recently by Ussing[6] The argument would apply to diffusion of a solute if solvent passage through the pores interfered with or assisted passage of solute A possible example of this effect has been observed (Harris, unpublished results) on the movement of sodium from muscle, if water is moved osmotically from the cells, there seems to be some added efflux of sodium ions

It is pertinent to remark here that some explanations of the anomalous rates of water movement have invoked a bulk flow of water due to an osmotic unbalance. As pointed out by Chinard[7], osmotic unbalance does not cause bulk flow

C Edwards
E J Harris

Department of Biophysics,
University College,
London, W C 1
Oct. 12

[1] Prescott, D M, and Zeuthen, E, *Acta Physiol Scand*, 28, 77 (1953)

[2] Hevesy, G, Hofer, E, and Krogh, A, *Skand Arch Physiol*, 72, 199 (1935) Koefoed-Johnsen, V, and Ussing, H H, *Acta Physiol Scand*, 28, 60 (1953)

[3] Keynes, R D, *Proc Roy Soc*, B, 142, 359 (1954)

[4] Hodgkin, A L, and Keynes, R D, *J Physiol*, 125, 15 *P* (1954)

[5] Bernal, J D, and Fowler, R H, *J Chem Phys*, 1, 515 (1933)

[6] Ussing, H H, in "Recent Developments in Cell Physiology" (Butterworths, London, 1954)

[7] Chinard, F P, *Amer J Physiol*, 171, 578 (1952)

Incidence of Hæmoglobin C in the 'Coloured' Population of Cape Town

HÆMOGLOBIN C, an electrophoretically abnormal variant of human hæmoglobin, has recently been reported from West Africa by Lehmann and Edington[1] In the United States, from which the abnormality was first described, Smith and Conley[2] found the hæmoglobin C trait in 2 per-cent, and Schneider[3] in

3 per cent, of American negroes. The American negro has an average incidence of the sickle-cell trait, which is dependent on another abnormal hæmoglobin, of about 8 per cent[4]. The sickle-cell gene was brought to America from Africa by the slave trade; it seems possible that the same may be true of the gene for hæmoglobin *C*. In West Africa, Edington and Lehmann[5] found hæmoglobin *C* to be present in 12 per cent and sickling in 20 per cent of two hundred negro out-patients. Thus the incidence of hæmoglobin *C* in African populations, for many of which the sickling incidences are known, will be of interest.

The 'coloured' population of Cape Town is derived from European, Hottentot, Bantu and Malay elements. In the seventeenth century also one ship-load of slaves from West Africa was imported into the Cape settlement. The Bantu elements came chiefly from Madagascar and Mozambique, while the 'Malays' were from India and Ceylon as well as from the Malay Archipelago[6]. The incidence of sickling in the coloured population is 0·6 per cent[7].

Blood specimens sent to the laboratory for routine serological tests were examined for abnormal hæmoglobins by paper electrophoresis. All age-groups and both sexes were represented among the subjects, but adult females predominated. A modified apparatus of Kunkel and Tiselius[8] was used, with Whatman's No. 1 filter paper and a barbitone buffer of *p*H 8·6 containing 1·84 gm. diethylbarbituric acid and 10·3 gm. per litre of its sodium salt. Washed packed red cells were diluted with approximately two volumes of buffer and lysed by freezing and thawing. The hæmoglobin preparations were run for 3 hr. at a potential gradient of about 12 V./cm., and the patterns stained with bromphenol blue. In 219 examinations, two examples of a hæmoglobin of similar mobility to hæmoglobin *C* were found. In each case the abnormal hæmoglobin was associated with a normal component, in the typical form of the hæmoglobin *C* trait. Both occurred in clinically healthy females attending an antenatal clinic, and the findings were verified by repeated runs alongside specimens from known carriers of sickle-cell hæmoglobin. Fig. 1 shows three typical patterns.

The incidence of hæmoglobin *C* in the Cape coloured population thus appears to be about 0·9 per cent, that is, of the same order as the sickling incidence. Further studies of this and other African groups are in progress.

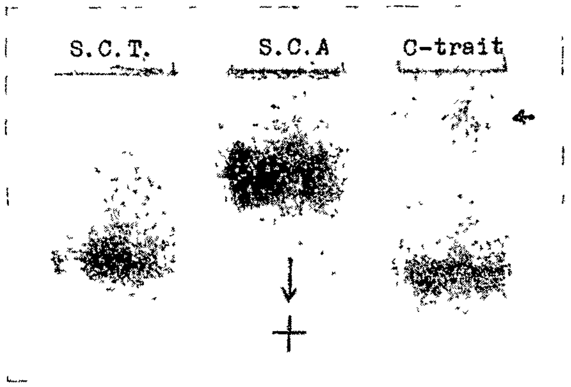


Fig. 1. Electrophoretic patterns from bearers of the hæmoglobin *C* trait (the arrow points to the *C* component), the sickle-cell trait (S.C.T.) and a patient with sickle-cell anæmia (S.C.A.)

I am grateful to Prof. J. V. Neel, of the University of Michigan, for encouragement, and to Dr. I. D. Davids for help in obtaining specimens.

PETER BRAIN

Department of Pathology,
University of Cape Town.
Oct. 5.

[1] Lehmann, H., and Edington, G. M., *Lancet*, i, 974 (1954).
[2] Smith, E. W., and Conley, C. L., *Bull. Johns Hopkins Hosp.*, 93, 94 (1953).
[3] Schneider, R. G., *J. Lab. Clin. Med.*, 44, 133 (1954).
[4] Margolies, M. P., *Amer. J. Med. Sci.*, 221, 270 (1951).
[5] Edington, G. M., and Lehmann, H., *Trans. Roy. Soc. Trop. Med. Hyg.*, 48, 332 (1954).
[6] Marais, J. S., "The Cape Coloured People" (London, 1939).
[7] Esrachowitz, S. R., Friedlander, S., Radloff, G., and Saunders, S., *S. Afr. Med. J.*, 26, 239 (1952).
[8] Kunkel, H. G., and Tiselius, A., *J. Gen. Physiol.*, 35, 89 (1951).

THE discovery of hæmoglobin *C* has recently been followed by that of hæmoglobin *E*[1]. Hæmoglobin *C* is usually identified by its behaviour on paper electrophoresis in alkaline buffer. Hæmoglobin *E* behaves so similarly in this investigation that a newly found abnormal hæmoglobin showing the properties of hæmoglobin *C* can only be identified as such after comparison with both *E* and *C*. This seemed particularly important when Dr. P. Brain discovered the hæmoglobin *C* trait in Cape coloured individuals. Hæmoglobin *C* has been found in American negroes and in the Gold Coast, but so far it has not yet been possible to demonstrate its presence in East Africa. On the other hand, hæmoglobin *E* has been found in Asiatics, particularly in Siam[2] and recently in Ceylon[3]. As the Malays have contributed considerably to the Cape coloured element, it was important to see whether the hæmoglobin *C* was in fact *C* and not *E*. By the kindness of Miss Virginia Minnich, a sample of hæmoglobin *E* trait was made available, and it was possible to ascertain that what has been described as hæmoglobin *C* in West Africa[4], and particularly the newly found hæmoglobin *C* of Dr. Brain, were in fact hæmoglobin *C*.

H. LEHMANN

Department of Pathology,
St. Bartholomew's Hospital,
London, E.C.1.

[1] Itano, H. A., Bergren, W. R., and Sturgeon, P., *J. Amer. Chem. Soc.*, 76, 2278 (1954).
[2] Chernoff, A. I., Minnich, V., and Chongchareonsook, S., *Science*, 120, 605 (1954).
[3] Graff, A. E., Ikin, E. W., Lehmann, H., Mourant, A. E., Parkin, D. M., and Wickremasinghe, R. L., *Proc. Phys. Soc.* (December 1954); *J. Physiol.* (in the press).
[4] Edington, G. M., and Lehmann, H., *Trans. Roy. Soc. Trop. Med. Hyg.*, 48, 332 (1954).

Endoparasitism in Trombiculid Mites

ENDOPARASITISM has hitherto been considered exceptional among the trombiculid mites and confined to the two genera *Hannemania* and *Endotrombicula*, the larvæ of which bury themselves in the skin of amphibians. Recent discoveries have, however, shown that endoparasitism is much more widespread among the Trombiculidae than has been suspected. Some of the endoparasitic forms are indeed very common but have been overlooked. Two distinct habits are recognized: burrowing in the skin, and living in the nasal cavities.

Intranasal species of trombiculids were first found by one of us while searching for pulmonary mites in rodents of Central Africa (Ruanda-Urundi and the Belgian Congo)[1]. A total of nine such species in four genera/subgenera (some of which are as yet undescribed), mostly related to *Schoutedenichia* Jadin and Verc and the Gahrliepinae[2], have since been found in the Congo More than eight other intranasal species have been found in Malaya and Borneo, mostly belonging to *Doloisia* (*sensu lato*) and to the *Euschongastia indica* group[3] A related species, *D. oculicola* (Wom , 1952) from Ceylon, is conjunctival. The intranasal species occur at all depths in the nasal cavities, and it is recommended that the entire head be split open after leaving it in the refrigerator overnight—this does not kill the mites. A most interesting finding in the Malayan rain-forest is that the spiny rat *Rattus rajah*, which is peculiar in being unusually lightly infested by external trombiculids (only three per rat), is the most heavily infested by the intranasal species (about seventy per rat). The same has been observed in the Congo for the Gambia rat, *Cricetomys dissimilis*

The second endoparasitic habitat is hypodermal or intradermal, the larvæ being either embedded in pits or even encysted and in some cases showing signs of metamorphosis *in situ*. The genus *Endotrombicula* itself appears to comprise slightly modified species of *Schongastia* which infest the skin of amphibians—this genus is now under revision. In the Congo, fifteen species in four genera (including Gahrliepines) have been found to be hypodermal in rodents, while Lieut -Colonel R. Traub (Traub, R , and Morrow, Mary L , in the press) has found a hypodermal species of *Gahrliepia* nr. *decora* Wom , 1952, in a rat in North Borneo.

These endoparasitic forms are of exceptional taxonomic importance as well as of great biological interest It is to be hoped that this communication will stimulate a wider attention to them

J R AUDY
Institute for Medical Research,
Kuala Lumpur, Malaya
P H VERCAMMEN-GRANDJEAN
Laboratoire Médical Provincial du Kivu,
Bukavu, Belgian Congo.
Nov. 1.

[1] Vercammen-Grandjean, P H , *Rev Zool Bot Afr* , 48, 17 (1953)
[2] Jadin, J B , Vercammen-Grandjean, P H , Herman, F , Thienpont, and Fain, A , *Rev Zool Bot Afr* , 49, 9 (1954) Jadin, J B , and Vercammen-Grandjean, P H *Rev Zool Bot Afr* (two papers in the press)
[3] Audy, J R , *Stud Inst Med Res* , *Malaya*, No 26, 159 (1954)

Polychaeta New to the British Isles

IN a recent survey of the littoral and sub-littoral Polychaeta of the Isle of Man, about seventy of the species found were new to the area and to the Irish Sea generally Among these are sixteen species which do not appear to have been recorded previously from the British Isles. The new records are

Hesionidae	*Podarke pallida* Claparède (ref 1)
Pilargiidae	*Ancistrosyllis groenlandica* McIntosh (ref 2)
Nephthydidae	*Nephthys rubella* Michaelsen (ref 1)
Eunicidae	*Staurocephalus neglectus* Fauvel (ref 1)
Paraonidae	*Paraonis gracilis* Tauber (ref 3)
	Paraonis fulgens (Levinsen) (ref 1)
	Aricidea suecica Eliason (ref 3)
	Aricidea (*Cirrophorus*) *branchiata* (Ehlers) (ref 4)
Apistobranchidae	*Apistobranchus tullbergi* (Théel) (ref 5)
Spionidae	*Scolelepis ciliata* (Keferstein) (ref 1)
Ctenodrilidae	*Zeppelinia dentata* Monticelli (ref 1)
Capitellidae	*Capitomastus minimus* Langerhans (ref 1)
Maldanidae	*Praxillura longissima* Arwidsson (ref 7)
	Nicomache trispinata Arwidsson (ref 1)
Terebellidae	*Polycirrus plumosus* (Wollebaek) (ref 6)
	Amaea trilobata Sars (ref 1)

Of these, the most interesting are *Ancistrosyllis groenlandica* and *Aricidea branchiata*. The former species was previously known only from the Davis Straits[2], the latter from South Africa[4], and in each case from a single specimen only. Neither has been recorded since the original description

A previous record of *Scolelepis ciliata* from the Isle of Man referred to specimens from a sea-water storage tank[8], while the present record is the first from a natural habitat

Of the remaining species, *Capitomastus minimus* is recorded at Naples and Madeira, and *Zeppelinia dentata* at Naples only[1] , all the rest are recorded from Scandinavia, the North Atlantic, the North Sea or the English Channel, and their occurrence in the British Isles is not surprising.

A fuller account of the survey is in preparation.

EVE C. SOUTHWARD
The Laboratory,
Citadel Hill, Plymouth.
Oct. 12.

[1] Fauvel, P , "Polychètes errantes", Faune de France, 5 (1923) "Polychètes sédentaires", Faune de France, 16 (1927)
[2] McIntosh, W C , *Trans Linn Soc Lond* (*Zool*), 1, 499 (1877)
[3] Eliason, A , *Acta Univ Lund*, 16, 1 (1920)
[4] Ehlers, E , "Wiss Ergebn 'Valdivia' ", 16, 1 (1908)
[5] Théel, H , *K Svensk VetenskAkad Handl* , 16, 3 (1879)
[6] Wollebaek, A *Skr VidenskSelsk* , *Christ* , 18, 1 (1912)
[7] Arwidsson, I , *Zool Jb* , Supp 9, 1 (1907)
[8] Judges, E C , and Southward, A J , Rep Mar Biol Sta Port Erin, 65, 24 (1953)

Role of Pectic Enzymes in the *Verticillium* Wilt Disease of Cotton

THE mechanism by which *Verticillium dahliae* produces symptoms of wilt disease in young cotton plants has been investigated by assaying solutions from cultures of the pathogen on liquid media for the following activities : (*a*) protopectinase, from the time taken to macerate standard slices of potato tuber tissue , (*b*) pectinesterase, from the rate of liberation of acidic groups from a solution of a high methoxyl pectin , (*c*) toxicity, from the rate of killing of parenchyma cells of potato tuber slices , (*d*) wilting, from the time taken to cause irreversible wilting of cotton shoots , (*e*) vascular browning, from the degree of discoloration of the vascular elements of cotton shoots.

Filtrates from cultures on a synthetic medium containing sucrose, potassium nitrate and mineral salts had little protopectinase activity, little or no pectinesterase activity, were relatively non-toxic to parenchyma cells and caused little vascular browning. Cotton shoots placed in these solutions wilted irreversibly in 8–10 hr Similar results were obtained after the solutions had been dialysed or autoclaved. When shoots were placed in these culture filtrates, it was observed that wilting was greatly delayed when conditions were unfavourable for transpiration. It was also noted that wilted shoots did not recover on transfer to water unless the lower part of the stems was removed In experiments in which water-uptake and water-loss from shoots placed in culture filtrates were followed gravimetrically, it was seen that while loss of water was only slightly reduced, uptake of water was greatly retarded by these filtrates

Solutions from cultures on a liquid medium containing glucose, ammonium sulphate, pectin and mineral salts had quite different properties These solutions had high protopectinase activity, and caused irreversible wilting of shoots in 8–10 hr. , these shoots also showed pronounced browning. The filtrates had little or no pectinesterase activity. On autoclaving, protopectinase activity was lost and toxicity to parenchyma cells was very much reduced, as was also the ability to cause vascular browning. The wilting activity of these solutions was, however, little affected.

It would seem, therefore, that the ability of these culture filtrates to cause wilt cannot be ascribed to enzyme activity; the development of other, equally characteristic, symptoms of disease such as vascular browning may well, however, be caused by the activity of one or more enzymes. A certain amount of evidence has been obtained which indicates that the enzymes responsible for protopectinase activity may be active in this respect.

In recent work of a similar nature with the wilt disease of tomato plants caused by *Fusarium oxysporum f. lycopersici*[1,2], pectinesterase was considered to play an important part in the development of typical disease symptoms. Since culture filtrates of *V. dahliae* had little or no pectinesterase activity, this enzyme played no part in the development of wilt symptoms in the experiments described above. It may also be noted that a highly active pectinesterase preparation from orange peel was far less effective in producing disease symptoms than were the culture filtrates.

M. KAMAL
R. K. S. WOOD
Botany Department,
Imperial College of Science and Technology,
London, S.W.7.
Oct. 19.

[1] Gotheskar, S. S., Scheffer, R. P., Walker, J. C., and Stahman, M. A., *Phytopath.*, 43, 535 (1953).

[2] Winstead, N. N., and Walker, J. C., *Phytopath.*, 44, 153 (1954).

Physiological Disease of Rice attributable to Iron Toxicity

In the course of an investigation on the influence of the intensity of reduction of a submerged soil on the growth and yield of rice, it was observed that three of the twenty-seven treatments studied exhibited symptoms strongly suggestive of a widespread disease of rice of unknown cause, described in the literature as 'mentek' in Java[1-3], 'penyakit merah' in Malaya[4], browning disease in Ceylon[5,6], and under various local names in India and Burma[2,7,8].

The symptoms were first observed about five weeks after transplanting in submerged soil, when brown spots began to appear on the older leaves. Gradually, the tips of these leaves took on a reddish-brown colour which spread towards the base, especially along the edges. As the disease progressed, these parts turned brown, dried up and curled inwards. In the early stages, the younger leaves and the unaffected parts of the older leaves were green; but with time the younger leaves also began to show the brown speckling, while the older leaves finally dried up completely giving the plant a scorched appearance. The closest examination of the lesions on the leaves failed to reveal the presence of any suspect organism. The effect on growth, flowering and final yield varied with the severity of the disease. In mild cases growth, though retarded, was not seriously affected and rapid recovery was made about the time of heading. The yield of grain was not appreciably below that of the unaffected plants. The severely affected plants were markedly stunted, tillered poorly, headed late, and produced thin, narrow panicles with a high proportion of sterile florets. Roots of the diseased plants were poorly developed, coarse in texture, and dark brown in colour, in contrast to the profuse fine-textured, reddish-brown roots of the unaffected plants.

These symptoms are somewhat akin to those of potassium deficiency, and have, in fact, been ascribed to it[1,2,8,9]. However, in view of the high initial level of exchangeable potassium in these experiments, potassium deficiency may be excluded as the direct cause of the disease. The chemical analyses of the percolates taken from the pots at intervals during the period of growth appear to provide an explanation of the disturbance. A close association was noted between the severity of the disease and the concentration of reduced products, especially ferrous iron, in the percolates. This is summarized in Table 1.

Table 1

Symptoms	Av. wt. (gm.) per pot of 6 plants			Ferrous iron (p.p.m.) in percolates on		
	Grain	Straw	Roots	17/8*	3/9	6/10
None	28.2	61.4	30.0	3.2	20.5	80.0
Mild	23.6	53.4	25.7	35.8	81.6	354
Moderate	16.6	41.0	16.3	88.3	207	435
Severe	4.9	20.8	5.7	146	275	525

* Thus, 16 days after flooding and transplanting

The symptoms were absent in the treatments in which (*a*) there was drainage, (*b*) there was a high initial concentration of nitrate, (*c*) submergence was delayed, (*d*) sodium nitrate was added to retard the reduction process.

We have no first-hand experience with the disease under field conditions, but a consideration of the following features[3] of the disease has led us to the view that the disturbance observed under greenhouse conditions and the physiological disease described in the literature probably have a common cause: (*a*) the disease affects only lowland rice; (*b*) it is associated with very poor drainage; (*c*) it appears when fields have been unduly long under water prior to planting; (*d*) draining the fields is a common remedial measure. We hesitate to make any general recommendations from this limited study, but we suggest that any remedial measures should be directed towards reducing the accumulation of ferrous iron. Among the practical ways of doing this are: delaying submergence after transplanting, providing controlled subsoil drainage, minimizing the addition of organic matter, and using sodium nitrate to retard the reduction process.

Further experiments are in progress and a detailed report will be published elsewhere.

F. N. PONNAMPERUMA
R. BRADFIELD
M. PEECH
Department of Agronomy,
College of Agriculture,
Cornell University,
Ithaca, New York.
Oct. 12.

[1] Goor, G. A. W. van de, *Neth. J. Agric. Sci.*, 2, 44 (1954).

[2] Ramiah, K., Int. Rice Comm. News Letter No. 3 (1952).

[3] Vecht, J. van der, Pemb. Balai Besar Penj. Pert. No. 113 (1953).

[4] Johnston, A., Int. Rice Comm. News Letter No. 10 (1954).

[5] Grist, D. H., "Rice" (Longmans, Green and Co., London, 1953).

[6] Joachim, A. W. R., Admin. Rep. Direc. Agric. Ceylon (1950).

[7] Aiyer, S. P., *Proc. Ind. Acad. Sci.*, 28, B, 202 (1948).

[8] Saran, A. B., *Curr. Sci.* 18, 378 (1949).

[9] Kulman, L. W., cited in refs. 2 and 3.

The Gregarious Setting Reaction of Barnacles as a Measure of Systematic Affinity

PREVIOUS experiments have shown that cyprids are stimulated to settle and metamorphose by contact with the epicuticle of barnacles of their own species[1]. Other species are comparatively ineffective in promoting settlement The question remained whether other species have any stimulating effect at all and, if so, whether closely related species are more effective than barnacles of other families. To investigate this, seven parallel series of twenty-five experiments were carried out In each experiment twenty freshly collected cyprids of *Balanus balanoides* were presented with a flat stone, weighing between 5 and 15 gm and of rough granite, in a crystallizing dish holding about 250 ml of sea water. In one of the series the stones were bare In five other series two or three recently detached and active adult barnacles, belonging respectively to the five species listed in Table 1, were placed on top of each stone Some of these species differed from *B balanoides* in profile and activity, *Verruca* being flatter and *Chthamalus* less active The setting behaviour of cyprids is considerably affected by surface topography[2] and water currents (Crisp, private communication), so a seventh series of experiments was included, in which disarticulated shell plates of *B balanoides* were laid flat on the stones, there being no live adult barnacles to disturb the water

Table 1

Series No	Species on stones	Family represented	No of cyprids of *B balanoides* settled in 24 hr	Total
1	None		0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0
2	*Chthamalus stellatus*	Chthamalidae	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0
3	*Verruca stroemia*	Verrucidae	0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2
4	*Elminius modestus*	Balanidae	0 0 0 1 0 0 0 5 3 2 0 0 0 3 0 0 0 0 0 0 0 0 0 1 0	15
5	*Balanus crenatus*	,, ,,	1 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 0 0 0 0 0 1 6 0 0	13
6	*Balanus balanoides*	,, ,,	0 0 1 0 1 2 2 2 7 6 0 7 2 4 0 0 1 0 0 3 6 14 9 1 3	71
7	Shells only of *B balanoides*	,, ,,	0 0 0 2 0 0 2 3 4 0 2 1 7 3 1 4 0 0 0 1 1 1 8 0 0	40

After twenty-four hours, the numbers of cyprids which had cemented themselves to the stones were recorded (Table 1) Many settled on stones bearing adults or shell plates of their own species, and significant numbers settled on those bearing other species belonging to the same family (Balanidae). *Elminius modestus* had about as much effect in stimulating settlement as *Balanus crenatus*, a fact agreeing with the evidence from the anatomy of both adults[3] and larvæ[4] that these two genera are very closely related. The representatives of the other families of sessile barnacles (Verrucidae and Chthamalidae) had no appreciable stimulating effect, presumably because their epicuticles are too different, in chemical composition or minute sculpturing, from that of *Balanus*.

Evidently the discriminatory powers of gregarious larvæ can be used to provide evidence of the degrees of relationship between related species. It is intended to investigate the interrelationships of the British species of *Spirorbis* (Serpulidae) by this method. *Spirorbis* provides very favourable material for such experiments[5], and the genus needs systematic revision.

E W. KNIGHT-JONES

Marine Biology Station,
University College of North Wales,
Bangor. Oct. 26.

[1] Knight-Jones, E W, and Crisp, D J, *Nature*, **171**, 1109 (1953) Knight Jones, E W, *Brit J Exp Biol*, **30**, 584 (1953)

[2] Crisp, D J, and Barnes, H, *J Anim Ecol*, **23**, 142 (1954)

[3] Darwin, C, "A Monograph of the Subclass Cirripedia", **2**, Balanidae (Ray Society, London, 1854)

[4] Knight-Jones, E W, and Waugh, G Duncan, *J Mar Biol Assoc U K*, **28**, 413 (1949) Jones, L W G, and Crisp, D J, *Proc Zool Soc Lond*, **123**, 765 (1954)

[5] Knight-Jones, E W *J Mar Biol Assoc U K* **30**, 201 (1951)

Independence in Publication

MR ARTHUR BRYANT once told a story which is typical, one hopes, of the sturdy independence of the British people A dock strike was on, and enormous lorries were going in and out with impressive notices "By the authority of H.M. Government", or "By permission of the T U C ". Among them was a tiny donkey cart, driven by a little old man with a bashed-in bowler on the cart was a notice "By my own bloody authority".

In the pages of *Nature*, and of other journals, are many papers whose authors find it necessary to thank the Director of This, or the Chief Scientist of That, or the Ministry of Something or Other, for permission to publish them There is nothing imaginably secret about most of these, during the past year they have dealt with such matters as boiler scale, aircraft noise, paper electrophoresis, internal stress in glass, the sexing of the confused flour beetle and the ageing of quartz crystals Senator McCarthy is unlikely any more to make trouble between Britain and the United States because of such revelations nor could a sensible director of research feel anything but amused shame that anyone should need to ask his permission to reveal them

Could not this nonsense stop ? It would still be possible, if they wished, for the chief scientists, who are really quite amiable people, to follow the example of the late Lord Knutsford of the London Hospital, at the end of a meeting over which he presided "And now I have one particularly pleasant duty to perform—to propose a unanimous vote of thanks to myself for the excellent manner in which I have conducted the business" The occasional performance of a simple rite of that kind would obviate the necessity of requiring authors to thank (for example) the Director of Pedicular Research in the Ministry of Provocation for allowing them to publish their results (say) on the mean free path of insect vectors of disease

This letter is published without the permission of the professor of physiology in this College.

A V. HILL

Department of Physiology,
University College,
London, W C 1 Dec. 17

[Prof Hill's anecdote in the first paragraph of his communication reminds us of the early days of the War. As soon as war was declared, it seemed that the majority of motor-cars appeared in the streets labelled "A R P ", "C D ", "Doctor" and a high percentage just vaguely "Priority" One day in a London street we saw a car labelled "Just me".—EDITORS]

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 7

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on "The Problem of Radio Interference"

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Dr H G Taylor—Presidential Address

University of London (at King's College, Strand, London, W C 2), at 5 30 p m —Dr G B Jeffery, F R S "Universities and the Teaching Profession" * (From a series of lectures on "Looking Forward in Education")

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 30 p m —Mr Duncan Carse "South Georgia Survey"

Tuesday, February 8

Institution of British Agricultural Engineers (at the Institution of Electrical Engineers, Savoy Place, London, W C 2), at 2 15 p m —Mr F S Mitchell and Mr G Shepperson "The Effects of Mechanical Treatment on the Drying Rate of Hay in the Field" *

Physical Society, Low Temperature Group (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S W 7), at 4 30 p m —Symposium on "The Properties of Solid Argon"

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N W 1), at 5 p m —Scientific Papers

University of London (at Bedford College, Regent's Park, London, N W 1), at 5 15 p m —Prof Max Black (Cornell University) "The Analysis of Necessary Statements" * (Further lectures on February 11 and 16)

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr E W Bruce, Mr R F Strickland-Constable and Prof D M Newitt "The Mechanism of Drying of Solids"

Institution of Civil Engineers (at Great George Street, Westminster, London, S W 1), at 5 30 p m —Mr C D C Braine "The Effect of Storage on Sewerage Design"

Institution of the Rubber Industry (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W 1), at 5 30 p m —Mr E R Amery "Some Practical Aspects of Automatic Control in the Rubber Industry" , 7 p m —Mr G E Bessey "Properties of Whiting and other Calcium Carbonates used as Fillers in Rubber"

Society for Analytical Chemistry, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Meeting on "Solvent Extraction"

Wednesday, February 9

Parliamentary and Scientific Committee (in the River Room, Savoy Hotel, Strand, London, W C 2), at 11 30 a m —Annual General Meeting

Institute of Petroleum (at 26 Portland Place, London, W 1), at 5 30 p m —Dr C G Williams "Applicational Research in the Petroleum Industry"

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr J K S Jowett and Mr G O Evans "A Study of Commercial Time Lost on Transatlantic Radio Circuits due to Disturbed Ionospheric Conditions" , Mr A M Humby, Mr C M Minnis and Mr R J Hitchcock "Performance Characteristics of High-Frequency Radio Telegraph Circuits"

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Mr D S Miller "The Nutritive Value of Fish Proteins" , Mr L C Baker "Some Aspects of the Photochemical Oxidation of Ascorbic Acid"

Institution of Mechanical Engineers, Applied Mechanics Group (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 45 p m —Discussion on "The Use of Models"

Royal Institute of Chemistry, London Section (joint meeting with the Reading University Chemical Society, at the University, Reading), at 8 p m —Sir William Penney, F R S "Explosions"

Thursday, February 10

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Mr G M Sisson "The Research Activities of Grubb Parsons"

Institute of Physics, Industrial Spectroscopy Group (at 47 Belgrave Square, London, S W 1), at 5 30 p m —Prof W M H Greaves, F R S "Astronomical Spectroscopy"

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m —Dr T S Work "Protein Biosynthesis" * (From a series of lectures on "The Scientific Basis of Medicine")

University of London (in the Electrical Engineering Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Dr A L Cullen "The Measurement of Microwave Power using Electro-Mechanical Forces" * (Further lectures on February 17, 24 and March 3)

Royal Aeronautical Society (at Saunders-Roe Club House, Cowes, Isle of Wight), at 7 p m —Prof A D Baxter "Problems and Prospects of Rocket Propulsion for Aircraft"

Friday, February 11

Royal Astronomical Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Annual General Meeting

University of London (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W C 2), at 5 p m —Prof A Bertrand (École Nationale d'Administration, Paris) "The Recruitment and Training of the Higher Civil Servants in the United Kingdom and in France—a Comparative Study" *

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S W 1), at 5 30 p m —Mr L W Bryant and Mr C F Cowdrey "Effects of Velocity and Temperature of Discharge on the Shape of Smoke Plumes from a Funnel or Chimney"

North East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre of the Mining Institute Neville Hall, Newcastle-upon-Tyne), at 6 15 p m —Prof J A Pope and Dr J Fitzgeorge "Temperature Measurements on Marine Diesel Engine Pistons"

Institute of Physics, Non-Destructive Testing Group (at 47 Belgrave Square, London, S W 1), at 6 30 p m —Mr S Jefferson "Industrial Applications of Radioactive Isotopes"

British Association of Chemists, London Section (at the Wellcome Institute, 183 Euston Road, London, N W 1), at 7 p m —Mr J B Davies "Work Study as Applied to the Chemical Plant Layout"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Dr A B Pippard "Superconductivity"

Saturday, February 12

British Psychological Society, Northern Branch (at the University, Leeds), at 2 30 p m —Symposium on "Communication"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer in Horticulture—The Clerk of the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex (February 12)

Senior Analytical Chemist (with a degree or equivalent qualification, and preferably with experience in water, sewage and trade waste analysis), and a Junior Analytical Chemist (with a degree or equivalent qualification), in the Laboratories of the Pollution Prevention Department, Severn River Board—The Clerk, Severn River Board, Portland House, Church Street, Great Malvern, Worcestershire (February 12)

Research Fellow (organic chemist with experience of research, preferably on natural products) in the Department of Chemistry, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (February 15)

Chemist or Physicist, Experimental Officer grade (with at least H S C (science) or equivalent, and preferably with some knowledge of electronic equipment), at a Ministry of Supply Research Establishment, near Bridgend, Glamorgan, for experimental work on the chemical and physical properties and the measurement of performance characteristics of pyrotechnic systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting F 18/5A (February 19)

Farms Director and Lecturer (with a degree or diploma in agriculture, together with practical farm management experience) in Farm Management—The Principal, Royal Agricultural College, Cirencester (February 19)

Metallurgist (with a good honours degree in metallurgy or equivalent professional qualifications, a good knowledge of physical metallurgy and of technology of engineering and constructional materials, including light alloys and/or special steels), at the Central Research Establishment, National Coal Board, Isleworth, Middlesex, to carry out research on metallurgical problems arising in mining operations—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/918 (February 19)

Deputy Director of the Institute of Education—The Registrar The University, Leeds 2 (February 21)

Physicist or Mathematician (with a first- or second-class honours degree in physics or mathematics), at the Ministry of Supply Headquarters, London, to investigate data reduction associated with ballistic instrumentation with a view to improving methods of presentation of results and to introducing methods of analysis applicable to automatic computing machines—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 7/5A (February 24)

Engineer (with a good honours degree in mechanical engineering or equivalent professional qualifications, and preferably some experience in research) at the Central Research Establishment, National Coal Board, Isleworth, Middlesex, to carry out research on underground transport of coal—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/922 (February 26)

Lecturer or Assistant Lecturer in Sociology, and a Demonstrator in Pharmacology—The Registrar, The University, Leeds 2 (February 26)

Staff Tutor in Science (Physics) in the Department of Adult Education—The Registrar and Secretary, The University, Bristol 8 (February 26)

Lecturer in Applied Mathematics—The Registrar, King's College, Newcastle-upon-Tyne (February 28)

Lecturer in the Department of Logic and Metaphysics—The Secretary, The University, Edinburgh (February 28)

Lecturer (with an honours degree in physiology and experience in teaching experimental physiology to honours students) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College, Regent's Park, London, N W 1 (February 28)

Reader in Experimental Physics at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W C 1 (March 3)

Chemist, Assistant Experimental Officer or Experimental Officer grade (with H N C in chemistry or equivalent qualification, and good experience of modern methods of analysis), for the mineral analysis of plants—The Secretary, East Malling Research Station, near Maidstone, Kent (March 5)

Chair of Applied Science, with special reference to engineering, tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W C 1 (March 7)

Lecturer or **Assistant Lecturer in Geography** at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (March 15)

Scientific Officer (with a good honours degree in chemistry, biochemistry or botany, a sound knowledge of organic chemistry, and a keen interest in the living plant) IN THE BIOCHEMISTRY SECTION for research on the biochemistry and metabolism of the fruit tree—The Secretary, East Malling Research Station, near Maidstone, Kent (March 15)

Lecturer or **Senior Lecturer** (graduate in physics, extensive research experience of solid state physics and preferably of semiconductors) IN THE DEPARTMENT OF APPLIED PHYSICS—The Registrar, College of Technology, Manchester 1 (March 19)

Research Fellow in Electron Physics—The Registrar, The University, Edgbaston, Birmingham (March 26)

Chair of Chemical Technology—The Secretary, The University, Edinburgh (March 28)

Scientific Officer (with a good honours degree and a keen interest in field entomology, and preferably with research experience) IN THE ENTOMOLOGY SECTION for studies on Tortricids and leaf hoppers associated with tree and bush fruits—The Secretary, East Malling Research Station, near Maidstone, Kent (April 15)

I C I Research Fellows in Chemistry, Physics and allied subjects—for example, PHARMACOLOGY, ENGINEERING and METALLURGY—The Registrar, The University, Manchester 13 (April 30)

Biochemical Technician (preferably with experience of manometric techniques or in the isolation of natural products), and a **Technician in the Physical Chemistry Laboratory**, for work particularly concerned with spectroscopic techniques—The Chester Beatty Research Institute (Institute of Cancer Research, Royal Cancer Hospital), Fulham Road, London, S W 3, quoting "Biochemistry" or "Spectroscopy"

Engineers and **Physicists** (with a first- or second-class honours degree or equivalent in physics or engineering) IN THE INSTRUMENTATION SECTION, Royal Aircraft Establishment, Farnborough, Hants, for (*a*) research in techniques and instrumentation for the measurement and recording of physical quantities arising from tests in aircraft and missiles, and (*b*) research on electronic circuits and equipment for flight test, wind tunnel and allied aeronautical research purposes—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 13/5A

Experimental Officer (with H S C (science) or equivalent, and a knowledge of physical chemistry, and preferably some metallurgical experience), at the Royal Aircraft Establishment, Farnborough, Hants, for research work on metal extraction processes—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting F 19/5A

Headmaster (graduate in science and experience of the organization and administration of technical schools, and appropriate teaching experience) of a Technical High School at Dacca, Pakistan—The Ministry of Labour and National Service, Almack House, 26–28 King Street, London, S W 1, quoting A.12/PE 74/53

Physicist (with at least H S C (science) or equivalent, and preferably with experience in metallography or in the operation and servicing of electron microscopes) at a Ministry of Supply Research Establishment in South East London, to assist in work involving the application of microscope technique, including electron microscopy, to metallurgical and explosive properties—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 8/5A

Postgraduate Studentships in (*a*) **Applied Genetics and Plant Breeding**, and (*b*) **Plant Physiology**—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S W 1

Research Assistant (with a first-class honours degree in metallurgy, physics or chemistry) for university work on structure of alloys of high melting point—Dr W Hume-Rothery, F R S, Inorganic Chemistry Laboratory, South Parks Road, Oxford

Research Fellow (organic chemist with experience of research, preferably on natural products) IN THE DEPARTMENT OF CHEMISTRY, University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1

Science and Mathematics Master—The Headmaster, Gordonstoun School, Elgin, Morayshire

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Aero Research Technical Notes Bulletin No 142 Synthetic Resin Glues in the Building Industry Part 1 Some Notes on New Timber Roof Trusses built with "Aerolite" 300 Pp 6 (Duxford Aero Research Limited, 1954) [1911

Building Research Station Digest No 70 (October, 1954) Som General Principles of the Lighting of Buildings Pp 8 (London H M Stationery Office, 1954) 3*d* net [191

Imperial College of Science and Technology (including The Roya College of Science, The Royal School of Mines, and the City an Guilds College) Proceedings of the Conference of Industrial Representatives—No 3, convened by the Vacation Work Committee of th Imperial College Union—London, 20th October, 1954 Pp iii+29 (London Imperial College of Science and Technology, 1954) [1911

Memoirs of the Royal Astronomical Society Vol 67, Part 1 Photographic and Photovisual Magnitudes of 7^m–10^m Stars on th +15° Selected Areas By A Beer, R O Redman and G G Yates Pp 50 (London Royal Astronomical Society, 1954) 20*s* [191

Laboratory Animals Bureau Collected Papers, 1954 Volume 2 The Design of Animal Houses Pp 75+7 plates (London Laboratory Animals Bureau, M R C Laboratories, 1954) 7*s* 6*d* [241

Department of Scientific and Industrial Research Road Researc Laboratory Road Research Technical Paper No 33, Further Studie on the Compaction of Soil and the Performance of Compaction Plant By W A Lewis Pp vi+46+8 plates (London H M Stationer Office, 1954) 3*s* net [241

Committee on Air Pollution Report (Cmd 9322) Pp 80 (London H M Stationery Office, 1954) 2*s* 6*d* net [291

Report of the Nature Conservancy for the year ended 30th September 1954 Pp iv+55+4 plates (London H M Stationery Office 1954) 3*s* net [291

Department of Scientific and Industrial Research Pest Infestatio Research Bulletin No 1 Fumigation with Methyl Bromide Unde Gas-Proof Sheets By W Burns Brown Pp vi+38+8 plates (London H M Stationery Office, 1954) 2*s* 6*d* net [301

The Rationalist Annual, 1955 Pp 81 (London C A Watts an Co, Ltd, 1954) 5*s* cloth, 2*s* 6*d* paper [301

Report on the Work of the British Council for the year ende 31st March 1954 Pp v+105 (London British Council, 1954 2*s* 6*d* [301

Freshwater Biological Association Scientific Publication No 14 A Key to the British Freshwater Leeches, with Notes on their Ecology By Dr K H Mann and Dr E V Watson Pp 21+1 plate (Ambleside Freshwater Biological Association, 1954) 2*s* 6*d* [301

Air Ministry Meteorological Office Handbook of Weather Messages Part 2 Codes and Specifications Second edition (M O 510b) Pp xx+113 (London H M Stationery Office, 1954) 4*s* 6*d* net [301

British Museum (Natural History) Expedition to South-Wes Arabia, 1937–8 Vol 1, Nos 25–26 Lepidoptera Rhopalocera B A G Gabriel Hemiptera Reduviidae By N C E Miller Pp 351–414+plates 18–21 (London British Museum (Natural History) 1954) 15*s* [301

Bulletin of the British Museum (Natural History) Entomology Vol 3, No 8 Neue Notiophygidae (Coleoptera) Von Hans John Pp 297–313+plates 13–17 7*s* 6*d* Vol 3, No 10 A Review of th *Aedes Scutellaris* Subgroup, with a Study of Variation in *Aedes Pseudoscutellaris* (Theobald), (Diptera Culicidae) By Elizabeth N Marks Pp 347–414+plate 18 18*s* Vol 3, No 11 A New Genus and Som New Species of the Chauliodini (Megaloptera) By D E Kimmins Pp 415–444 8*s* (London British Museum (Natural History) 1954) [301

Hilger Journal No 1 (November 1954) Pp 8 (London Hilge and Watts, Ltd, 1954) [301

Other Countries

Astronomical Papers prepared for the use of the American Epheme and Nautical Almanac Vol 13, Part 5 Perturbations of the Fiv Outer Planets by the Four Inner Ones By G M Clemence Pp 365–406 70 cents Vol 15, Part 1 Theory of the Rotation of th Earth Around Its Center of Mass By Edgar W Woolard Pp 166 1 50 dollars Vol 15, Part 2 The Mass of Saturn and the Motion o Jupiter 1884–1948 By Hans G Hertz Pp 167–216 70 cents (Published by the Nautical Almanac Office, U S Naval Observatory) (Washington, D C Government Printing Office, 1954) [1911

Physikertagung Innsbruck Hauptvortage von der Gemeinsamen Jahrestagung 1953 des Verbandes Deutscher Physikalischer Gesellschaften und der Österreichischen Physikalischen Gesellschaft Herausgegeben von H Auer, E Bruche und R Steinmaurer Pp iii+138 (Mosbach/Baden Physik Verlag, 1954) 19 20 D marks [2411

Indian Forest Bulletin No 175 (New Series) Timber Mechanic —Interlocking of Grain in Indian Timbers By V D Limaye Pp ii+4+2 plates 10 annas, 1*s* No 182 (New Series) Cellulos and Paper Indigenous Cellulosic Raw Materials for the Productio of Pulp, Paper and Board Part 20 Chemical Pulps from *Eupatorium odoratmu* Linn (Assam-lota) By R V Bhat and M G Karnik Pp ii+9 8 annas, 9*d* (Delhi Manager of Publications, 1954) [241

Editorial and Publishing Offices of " NATURE "
MACMILLAN & CO, LTD,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831. Telegrams Phusis Lesquare Londo

Annual subscription £6, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd, Crown House, 143–147 Regent Street, London, W
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Offic

PERMUTIT

ION EXCHANGE MATERIALS

The use of Permutit Ion Exchange Materials in many roles distinct from water treatment, has resulted in the development of numerous new industrial processes giving improved results and lower running costs. Some materials now available are —

Zeo-Karb Na A sulphonated coal product containing both strong and weak acid groups

Zeo-Karb 215. A nuclear sulphonated phenol resin containing also hydroxyl groups

Zeo-Karb 225. A unifunctional cross linked sulphonated polystyrene resin in bead form of high capacity and exceptional chemical and physical stability

Zeo-Karb 226. A unifunctional cross linked methacrylic acid resin in bead form containing only carboxyl groups as the ion active groups

De-Acidite E. A high capacity anion exchange material of medium basicity

De-Acidite FF A unifunctional very highly basic anion exchange resin in bead form based on cross linked polystyrene and containing quaternary ammonium groups.

De-Acidite G A unifunctional weakly basic anion exchange resin in bead form based on cross linked polystyrene and containing diethylamino groups •

De-Acidite H. A material similar to "De-Acidite G" but containing dimethylamino groups

Bio-Deminrolit. A mixed cation and anion exchange resin for demineralisation in a single column

Decalso F. A synthetic sodium aluminium silicate suitable for the separation and concentration of vitamins and hormones

Decolorite. A resin of high porosity for removing colour from solutions

Permaplex C-10. A highly selective cation exchange resin membrane containing SO_3H groups

Permaplex A-10. A highly selective anion exchange resin membrane containing quaternary ammonium groups.

For full technical information please write to THE PERMUTIT COMPANY LIMITED Head Office and Laboratories Dept V H 92, Permutit House, Gunnersbury Avenue, London, W 4 Telephone CHIswick 6431

Permutit Ion Exchange Materials — Made in Britain by British Labour

MODERN LABORATORIES

. . . individually planned and designed for their particular purposes Over half a century of widespread experience of different types of Laboratories enables us to offer suggestions and designs based on the best of present-day developments

Our Technical Department is always available for free consultation and advice

Some Laboratories recently equipped by us:
Production . . . . J. Lyons & Co. Ltd.
Routine . . . . Express Dairy Co. Ltd.
Research, Routine, etc. . . . Glaxo Laboratories Ltd.
Chemical . . . . . . University College, London

With acknowledgments to Glaxo Laboratories Ltd.

CHARLES HEARSON & COMPANY LIMITED

68 WILLOW WALK, BERMONDSEY, LONDON, S.E.1. **(BER. 4494—4 lines)**

LECTURES AND COURSES

BIRKBECK COLLEGE

(UNIVERSITY OF LONDON)

SESSION 1955-1956 BEGINS MONDAY OCTOBER 3, 1955

Part-time (Evening) Courses provided for Internal Degrees in the Faculties of Arts and Science and for the Academic Postgraduate Diploma in Psychology Facilities also provided for part-time and full-time students reading for higher degrees in arts and science Applications for admission should be made before June 1

Pamphlet and form of application may be obtained from the Registrar, Birkbeck College Malet Street, W C 1

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

(TECHNICAL OPTICS SECTION)

A course of eight lectures and an accompanying practical course on Thin Film Optics, by Dr W Weinstein, will be given on Tuesdays and Thursdays at 4 30 p m, commencing Tuesday, February 22, 1955 Fee for eight lectures, 2 gns, and for practical course 4 gns

For further details apply to the Registry Imperial College Prince Consort Road S W 7

UNIVERSITY COLLEGE

LONDON

(GOWER STREET, W C 1)

Four lectures by Dr S R Elsden (University of Sheffield) entitled ' Respiratory Mechanism in Bacteria " will be given on Thursdays, February 10, 17, 24, March 3 at 4 45 p m

Admission free, without ticket

E A L GUETERBOCK
Secretary

UNIVERSITY COLLEGE

LONDON

(GOWER STREET W C 1)

Dr E E Snell (University of Texas) will give a Public Lecture entitled " The Relationship of Structure to Catalytic Activities of Vitamin B_6 " on Monday, February 14 at 4 45 p m

Admission free without ticket

E A L GUETERBOCK
Secretary

UNIVERSITY COLLEGE

LONDON

FREE PUBLIC LECTURES, SPRING TERM 1955

Friday, February 18, at 5 30 Professor F Bergel, Attempts at Chemotherapy of Malignant Diseases Monday February 28 March 7, 14 at 4 45, Dr Joseph Needham New Light on Physico-Chemical Aspects of Morphogenesis

Complete list of public lectures from Publications Officer, University College London Gower Street W C 1 (stamped envelope required)

UNIVERSITY OF LONDON

Two lectures on (i) " Psychology and International Relations " and (ii) " Uses and Limitations of the Experimental Method in Social Psychology " will be given by Professor Otto Klineberg (UNESCO) at 5 30 p m on February 14 and 15 at University of London Senate House, W C 1

Admission free without ticket

JAMES HENDERSON,
Academic Registrar

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 to 64 inclusive, or a woman aged 18 to 59 inclusive unless he or she, or the employment is excepted from the provisions of the Notification of Vacancies Order, 1952

UNIVERSITY OF MANCHESTER

I C I FELLOWSHIPS

Applications are invited for the above Research Fellowships, founded by Imperial Chemical Industries Ltd tenable in the University and available for research in chemistry, physics and allied subjects—e g pharmacology engineering metallurgy The value of the Fellowships will be within the range of £600 to £900 per annum according to qualifications and experience

Regulations governing the award of the Fellowships may be obtained from the Registrar the University Manchester, 13 to whom applications should be sent not later than April 30 1955

SOUTH PACIFIC COMMISSION

PLANT AND ANIMAL QUARANTINE OFFICER

Applications are invited for the post of Plant and Animal Quarantine Officer with the South Pacific Commission The successful applicant will be appointed for a period from two to three years, and will be stationed at the Commission s headquarters in Noumea New Caledonia The Plant and Animal Quarantine Officer is required to carry out investigations, etc, relating to the control of plant and animal pests, diseases, and weeds in the South Pacific including supervision of a rhinoceros beetle research programme, operation of an information centre and reporting service and improvement of control and protective measures Applicants should have a university degree with good scientific qualifications and mature experience in the field of plant or animal pests or diseases and their control and prevention including quarantine measures Fluency in English and French is very desirable Commencing salary will be determined according to qualifications and experience, but will be not less than £Stg 1 600 plus a post allowance of £Stg 540 (single) or £Stg 901 (married)

Further information obtainable from the Secretary-General, South Pacific Commission, Noumea New Caledonia, to whom applications, supported by a detailed curriculum-vitae should be sent by March 31, 1955

UNIVERSITY OF LONDON

Applications are invited for I C I Research Fellowships in Biochemistry, Chemistry, Chemotherapy, Engineering Metallurgy, Pharmacology Physics or allied subjects tenable from October 1 1955, normally for three years in the first instance Salary not less than £750 per annum, with family allowances and F S S U

Information and application forms can be obtained from the Academic Registrar University of London, Senate House, W C 1 Applications must be received not later than April 16 1955

THE FOOT-AND-MOUTH DISEASE RESEARCH INSTITUTE

Applications are invited for a post of Research Assistant (female) Duties are concerned with research on serology of viruses Qualifications should preferably include B Sc (bacteriology) The post is superannuable and salary in accordance with nationally agreed scales related to age, qualifications and experience These are Assistant Experimental Officer grade (£372 at age 21, rising by eight increments to £540) or Scientific Officer grade (£467 by ten increments to £750)

Applications stating age, qualifications, details of past and present appointments and accompanied by the names of three referees should be addressed to the undersigned immediately

N SMITH,
Secretary

Pirbright,
Surrey

NATIONAL COAL BOARD INVITE APPLICATIONS for the undermentioned superannuable appointments at London Headquarters in the Pneumoconiosis Field Research (a long-term investigation into the incidence of pneumoconiosis among mine workers) Scientific Technical Officers Grade II or III (salary scales £515 by £20 to £735 male and £420 by £16 to £596 female, or £400 by £20 to £560 male and £325 by £16 to £453 female plus London location allowance of £32 10s minimum rising to £50 maximum), according to qualifications and experience Higher national certificate or similar qualification in mathematics is required There are two posts the duties of one include the handling of experimental data and the preparation of sampling schedules and programmes for investigators in the coalfields, and knowledge of mining practices and terminology is an advantage, duties of the other post include the supervision of junior computors and generally assisting with statistical work and a good knowledge of mathematics with extensive experience of statistical computing is required (Reference No TT/911) Scientific Technical Officers Grade IV (scale £2 19s a week at age of 15 rising to £8 10s a week male, and £7 female at age 27 plus London location allowance of 12s 6d a week) Duties are to assist in statistical calculation and analysis General certificate of education in mathematics is required and experience in statistical computing is desirable (Reference No TT/912)—Write giving full particulars (in chronological order) of age education qualifications and experience (with dates) to National Coal Board Establishments (Personnel) Hobart House Grosvenor Place London S W 1, marking envelope with the relevant TT Reference No Original testimonials should not be forwarded Closing date February 12, 1955

COMMONWEALTH of AUSTRALIA

APPOINTMENT NO 360/12 OF RESEARCH OFFICER

The Commonwealth Scientific and Industrial Research Organization invites applications for appointment to a position of Research Officer to the Tracer Elements Section at the University of Melbourne, Carlton This Section collaborates with other research units of the Organization on the application of radioactive tracer techniques and, in addition, undertakes an independent programme of research in aspects of radiochemistry The appointee will be expected to become familiar with all phases of the Section s work and to develop instrumental techniques particularly for the assay of radioisotopes He will also be responsible generally for the Section's electronic equipment Qualifications University honours degree in electrical engineering or science or equivalent qualifications with specialized knowledge of electronics Salary Dependent on qualifications and experience, commencing salary will be determined within the range of Research Officer £A 1 058 to £A 1 412 per annum actual thirteen increments subject to efficiency review at £A 908 and £A 1,064 per annum nominal Salary includes a cost of living adjustment of £A 198 per annum Fare to Australia (including those of wife and family) will be paid The appointment is subject to satisfactory medical examination and the appointee may be granted superannuation privileges

Applications referring to Appointment No 360/12, and stating full name place date and year of birth, marital state nationality present employment particulars of qualifications and experience and of war service, if any, accompanied by copies of not more than four testimonials and the names and addresses of two referees should reach the undersigned not later than March 5 1955

W IVES
Chief Scientific Liaison Officer

Australian Scientific Liaison Office,
Africa House,
Kingsway London, W C 2

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

Principal H Baker Ph D, A M I C E, A M I Mech E

Applications are invited for the post of Lecturer in Geology in the Department of Mining Applicants should have a degree or other recognized qualification in geology, together with some practical experience A knowledge of mining geology or special experience in the geology of coal will be an advantage Salary £965 by £25 to £1,065 per annum

Further particulars and form of application may be obtained from the Registrar, Nottingham and District Technical College, Shakespeare Street Nottingham, to whom completed forms should be returned not later than February 15 1955

F STEPHENSON,
Clerk to the Joint Education Committee

McMASTER UNIVERSITY

DEPARTMENT OF PHYSICS

GRADUATE ASSISTANTSHIPS

Applications are invited for part-time teaching and research assistantships in the Department of Physics McMaster University from persons qualified to register in courses leading to the M Sc and Ph D degrees Assistantships normally carry a yearly stipend of $1 450 to $1 850 Assistants are required to devote 10 to 12 hours per week to duties during the academic session (October to April inclusive) and are able to devote full-time to their research during the summer Research is in progress in the following fields Theory of Molecular Spectra F R Britton Atomic Mass Determinations H E Duckworth Cosmic Rays, F Gulbis Beta and Gamma Spectroscopy M W Johns, Microwave Diffraction A B McLay Solid State, H E Petch Theoretical Nuclear Physics M A Preston, Fission Yields and Isotopic Abundances H G Thode

Interested persons should write to Dr H E Duckworth Department of Physics, Hamilton College, McMaster University, Hamilton Ontario Canada

---

UNIVERSITY OF LEEDS

Laboratory Technician in Agricultural Bacteriology required preferably with experience in bacteriology, botany or chemistry also passes in science subjects in leaving certificate examination Salary according to experience on the scale 120s to 174s a week

Apply by letter within ten days of the appearance of this advertisement giving particulars of qualifications and experience also the names of two referees to Professor T L Bywater, Department of Agriculture, The University, Leeds, 2

WOLVERHAMPTON AND
TAFFORDSHIRE TECHNICAL COLLEGE

ipal C L Old, B Sc (Eng), M Sc (Tech)

plications invited for Senior Laboratory tant, Chemistry Section of Department of ied Science Applicants should be not less 25 years of age, have completed or be pt from national service, have had good inial or other laboratory experience, be able ndertake supervision of juniors, maintain atory equipment and control stores Superable post Medical examination Salary and tions Grade IV miscellaneous scales £440 20 per annum

ply by letter to Principal, Wolverhampton Staffordshire Technical College, Wulfruna t, Wolverhampton, giving age, education, fications and experience and two persons to reference may be made

G W R LINES,
Clerk to the Joint Education Committee

NETHERNE HOSPITAL
COULSDON, SURREY

boratory Technician, male or female, required nodern well equipped laboratory Must hold ciateship of the Institute of Medical Labora- Technology or an equivalent qualification ley Council salary scale and conditions of ser- Single accommodation available if required plications, giving full particulars of age, ex- nce and qualifications, together with the s and addresses of two referees, should be arded to the Physician Superintendent as soon ossible

---

COMMONWEALTH AGRICULTURAL BUREAUX
COMMONWEALTH INSTITUTE OF ENTOMOLOGY

plications are invited for an appointment as ologist, whose principal duty will be the mination of phytophagous and predatory of economic importance, but who would enjoy excellent opportunities for general matic work in the Acarina Candidates are it who show evidence of special interest or vement in this field The successful candiwould work in the British Museum (Natural ry) London The salary will be in a scale rises from £530 by annual increments to 0 per annum, with efficiency bars at £855 and 0 There is also a pay supplement that from £25 at £530 to £35 at £900 to £1,500 starting salary will be determined by age, fications and experience Superannuation be provided for under the F S S U

e closing date for applications is April 30 and full details of the appointment and ods of application can be obtained from the tor, Commonwealth Institute of Entomology, ueen's Gate, London, S W 7

UNITED BIRMINGHAM HOSPITALS
IINGHAM AND MIDLAND HOSPITAL WOMEN, SHOWELL GREEN LANE, SPARKHILL, BIRMINGHAM, 11

plications are invited for the post of Tech- i to the Biological Section of the Depart- of Clinical Endocrinology Duties will le routine biological assays and assistance biological research Salary and conditions rvice will be in accordance with Whitley

plications, stating age, qualifications and ex- nce, accompanied by two recent testimonials, d be submitted to the House Governor

---

CTURERS REQUIRED FOR B B C EN- cing Training Department, Evesham which ly equipped with sound and television broad- g apparatus Applicants should possess de- or higher national certificate in electrical en- ring or physics and be capable of training varying from operator to graduate Know- of r f fundamentals and transmission pulse ique, optics, audio frequency engineering or itics an advantage Salary according to fications and experience —Requests for appli- n forms to Engineering Establishment Officer, lcasting House, London, W 1, quoting ref 2N

SEARCH ASSISTANT (B Sc WITH gy or Physiology) required to train in histo- ical and physiological research methods in Neuropsych'atric Research Centre, Cardiff y £450 to £530 conforming to national health e regulations —Applications should be sent ice to the Secretary, Whitchurch and Ely itals Management Committee, Cardiff

---

AUSTRALIAN NATIONAL UNIVERSITY
RESEARCH SCHOOL OF PHYSICAL SCIENCES

M L Oliphant, F R S , Director

The Australian National University invites applications from qualified persons for the following positions on the research staff Each position carries superannuation on the F S S U pattern and a grant for family fares Each permanent position carries a further grant for removal expenses on taking up appointment The University assists new members of staff who are married to obtain houses , rooms are available for unmarried members in University House Annual increments where ranges are provided will be £A 50 Professor of Theoretical Physics Who will be head of the Department of Theoretical Physics, and whose advice will be sought in appointments to the positions named below Salary £A 3 000 per annum Reader in Theoretical Physics Salary within the range £A 2,100 to £A 2,400 per annum Senior Fellow Salary range to be determined within limits £A 1,900 to £A 2,350 per annum Fellow Salary range to be determined within limits £A 1,350 to £A 1 950 per annum Senior Research Fellows Commencing salary within range £A 1,650 to £A 2 100 , tenure three years, with possibility of renewal for further two years Research Fellows Commencing salary within range £A 1,100 to £A 1 650 tenure three years, with possibility of renewal for further two years Study leave entitlement in the case of Professors is one year in four on full pay, with a grant of up to £A 1,000 towards the cost of such leave , Readers one year in six and £A 800 , Senior Fellows one year in six and £A 700 , Fellows one year in seven and £A 500

Full particulars should be obtained from the Secretary Association of Universities of the British Commonwealth, 5 Gordon Square London, W C 1 The closing date for the receipt of applications, in Australia and London, is June 30, 1955

FLINTSHIRE EDUCATION COMMITTEE
FLINTSHIRE TECHNICAL COLLEGE
MATHEMATICS AND PHYSICS SECTION
GRADE B ASSISTANT IN PHYSICS

Applications are invited for the above position The assistant lecturer will be required to advise the Lecturer responsible for the section on matters pertaining to the teaching of physics and will be required to teach physics up to the standard of the university general degree Applicants should have good academic qualifications and appropriate teaching and other experience The salary will be in accordance with the Burnham scale

Forms of application which must be returned as soon as possible, may be obtained from the Director of Education, County Education Offices Mold, on receipt of a stamped addressed envelope Canvassing, either directly or indirectly will disqualify

---

WEIZMANN INSTITUTE OF SCIENCE
REHOVOTH, ISRAEL
CHAIM WEIZMANN MEMORIAL FELLOWSHIPS 1955-56
ESTABLISHED BY YAD CHAIM WEIZMANN

Applications are invited for the above, tenable for the academic year 1955-56, at the Weizmann Institute of Science The work of the Weizmann Institute is mainly devoted to fundamental research in the exact sciences Scientists who have done meritorious post-doctoral research are eligible The stipend consists of $3,000, plus up to $2,000 for fare, depending on distance from Israel Elections will be held in April

Further particulars may be obtained from the Academic Secretary Applications will be accepted up to March 10, 1955

THE IMPERIAL COLLEGE OF SCIENCE and technology invites applications for the following awards to undertake research on the growth of ice crystals A senior award of about £600 per annum, tenable in the Department of Meteorology for not more than three years, is offered to candidates with at least two years' research experience in experimental physics A junior award of about £350 per annum tenable in the Department of Chemical Engineering to graduates with high honours degree will be made for one year in the first instance but renewable for further one or two years Successful applicants will be expected to commence their duties as soon as possible—in any case not later than September 1, 1955 —Applications giving the names of two referees, should reach the Registrar not later than March 1, 1955

UNIVERSITY OF DURHAM
KING'S COLLEGE, NEWCASTLE UPON TYNE
DEPARTMENT OF MATHEMATICS

The Council of King's College invite applications for a Temporary Lectureship in Applied Mathematics The appointment will be for the academic year 1955-56 only and the salary will be determined at a suitable point within the range £650 to £1,350, in accordance with the qualifications and experience of the successful candidate Family allowance and F S S U

Further particulars may be obtained from the undersigned, to whom applications (three copies) together with the names of three referees, should be addressed so as to reach him not later than February 28, 1955

G R HANSON,
Registrar of King's College

UNIVERSITY OF DURHAM
KING'S COLLEGE, NEWCASTLE UPON TYNE
DEPARTMENT OF MATHEMATICS

The Council of King's College invite applications for a Lectureship in Applied Mathematics The commencing salary will be determined at a suitable point on the scale £650 by £50 to £1,350, in accordance with the qualifications and experience of the successful candidate Family allowance and F S S U

Further particulars may be obtained from the undersigned, to whom applications (twelve copies) together with the names of three referees, should be addressed so as to reach him not later than February 28, 1955

G R HANSON,
Registrar of King's College

UNIVERSITY OF LEEDS
DEPARTMENT OF ANAESTHETICS

Applications are invited from candidates trained in physiology and/or biochemistry for appointment as full-time Research Assistant in the Department of Anaesthetics at a salary of £400 a year The appointment is suitable for a science graduate intending to work for a higher degree and will be for one year in the first instance, subject to renewal Laboratory facilities will be provided

Applications (three copies), stating date of birth qualifications and experience, together with the names of two referees should reach the Registrar The University, Leeds, 2 (from whom further particulars may be obtained), not later than March 1, 1955

ROYAL TECHNICAL COLLEGE
SALFORD

Principal P F R Venables, B Sc , Ph D , F R I C

The Governors invite applications for the post of Head of the Chemistry and Applied Chemistry Department, duties to commence as soon as possible The post is recognized as a Grade V Department under the 1954 Burnham Committee Report on Scale of Salaries for Teachers in Establishments for Further Education, the salary being £1,515 by annual increments of £25 to £1,665 Candidates should preferably have teaching, industrial and/or research experience, and be capable of directing the growing amount of postgraduate courses and research in the Department

Forms of application and further particulars may be obtained from the Principal, Royal Technical College, Salford, 5, to whom applications should be returned as soon as possible

R RIBBLESDALE THORNTON
Clerk to the Governors

UNIVERSITY OF LIVERPOOL

Applications are invited for the following posts in the Department of Physics (i) Lecturer (Grade II), for which candidates should have had experience in either experimental or theoretical nuclear physics , (ii) Assistant Lecturer or Lecturer in the Subdepartment of Acoustics , at initial salaries according to age, qualifications and experience within the ranges current at the time of appointment for Lecturers and Assistant Lecturers Both appointments will commence on October 1, 1955

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than April 14 1955, by the undersigned, from whom further details may be obtained

STANLEY DUMBELL,
Registrar

THE SOCIETY OF CHEMICAL INDUSTRY has a vacancy for an Editorial Assistant with a knowledge of chemistry The appointment is intended to be permanent and progressive and the salary will be related to experience —Applications to the General Secretary, 56 Victoria Street London, S W 1

NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

ASSISTANT LECTURER IN AGRICULTURAL ENGINEERING

Applicants for this post should possess a degree in Engineering and/or in Agriculture with practical experience in Farm Implements and Machinery Salary scale according to age and qualifications on scales ranging from £419 2s to £936 14s per annum Superannuation scheme Applicants will be required to serve a probationary period of two years

Application forms and further particulars obtainable from the Secretary of the College, 41½ Union Street, Aberdeen, with whom applications should be lodged not later than February 16 1955

BOLTON AND DISTRICT HOSPITAL MANAGEMENT COMMITTEE

THE BOLTON ROYAL INFIRMARY
DEPARTMENT OF PATHOLOGY

Applications are invited for the appointment of Biochemist Candidates should hold an appropriate science degree or the A R I C The person appointed will work under the direction of the Principal Biochemist Whitley Council salary scale and conditions of service

Applications, stating age, qualifications, particulars of experience, etc, and the names of two referees, should be sent to the Group Secretary, The Royal Infirmary, Bolton, as soon as possible

LONDON, THE UNIVERSITY

GOLDSMITHS' COLLEGE

Required, Biology Laboratory Technician (man or woman) for work in laboratories covering B Sc (General) degree and Teacher Training Courses Previous experience and Intermediate City and Guilds examination an advantage though not essential Salary at current L C C rates

Apply, stating age, qualifications and experience to the Warden, Goldsmiths' College, New Cross, London, S E 14

UNIVERSITY OF LONDON

Applications are invited for Turner and Newall Research Fellowships in Engineering, Inorganic Chemistry, Physics or an allied subject, tenable from October 1, 1955, normally for three years in the first instance Salary not less than £750 per annum, with family allowances and F S S U

Information and application forms can be obtained from the Academic Registrar, University of London, Senate House, W C 1 Applications must be received not later than April 16, 1955

CHEMICAL ENGINEER REQUIRED BY the National Research Development Corporation to join a team engaged in research connected with the design and development of multimembrane electrodialysis cells and to supervise the construction of semi-technical scale demonstration plant Applicants should be between 24 and 30 years of age and should hold a degree in chemical engineering or physical chemistry with at least two years' postgraduate experience The appointment is tenable at the Low Temperature Research Station, Cambridge, and is for two years in the first instance Initial salary £700 to £900, according to experience The conditions are similar to those attaching to Research Fellowships—Application, giving full details of qualifications, should be made to the Superintendent, Low Temperature Research Station, Downing Street, Cambridge

---

RESEARCH ASSISTANT (MAN) WANTED as soon as possible for university work on structure of alloys of high melting point The position offers good opportunities for learning high temperature methods The work is arranged so that the man appointed qualifies as an advanced student for the Oxford D Phil degree Requirements First-class honours degree in metallurgy physics or chemistry Salary according to qualifications Applications from overseas cannot be considered, and men with second-class honours should not apply unless they have research experience—Applications to Dr W Hume-Rothery, O B E, F R S, Inorganic Chemistry Laboratory, South Parks Road Oxford

---

APPLICATIONS ARE INVITED FROM women holding degree in biology for appointment of Haematological Technician Previous experience in haematology not necessary In first instance appointment will be made in grade of Technician (£450 to £515 per annum) Promotion to the grade of Senior Technician (£540 to £625 per annum) will be made if satisfactory after probationary period of one year Salary and conditions according to Whitley Council—Apply Dr Mills, Royal Berkshire Hospital, Reading

UNIVERSITY OF MALAYA

SINGAPORE

Applications are invited from candidates holding degree in Pharmacy or Fellowship of Pharmaceutical Society for (1) Lectureship or (2) Assistant Lectureship in Pharmaceutics Salary scales (1) £1,148 by £49 to £1,442/£1,540 by £56 to £1,820 per annum (2) £1,001 by £49 to £1,099 per annum, according to qualifications and experience Allowances, expatriation in range £280 to £308 per annum, cost of living in range £210 to £560 per annum All paid in Malayan currency Free passages for appointee, wife and children under 12 years Part-furnished quarters at reasonable rent Provident fund scheme

Applications (six copies), naming three referees and detailing qualifications and experience, to be received by April 15, by Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1, from whom further particulars may be obtained

INSTITUTE OF DERMATOLOGY

BRITISH POSTGRADUATE MEDICAL FEDERATION
UNIVERSITY OF LONDON

Applications are invited for the appointment of Biochemist, preferably with hospital experience, who will be required to take charge of a new Subdepartment (at the In-patient Department of St John's Hospital for Diseases of the Skin at Homerton) under the general control of the Director of Pathology Grading and salary according to age, experience and qualifications Candidates must have aptitude and inclination for research having a bearing on Dermatology

Immediate application should be made to the Secretary, Institute of Dermatology, St John's Hospital for Diseases of the Skin, Lisle Street, Leicester Square W C 2, from whom further particulars concerning the appointment can be obtained

KING'S COLLEGE HOSPITAL

DENMARK HILL, S E 5

Applications are invited for the post of Biochemist in the Chemical Pathology Laboratory, which becomes vacant on March 14 The conditions of service are as laid down by the Professional and Technical Council of the Whitley Councils An honours degree in chemistry or an equivalent qualification will be considered an advantage

Applications, in writing, stating age, education and experience, together with the names and addresses of two referees to Professor Gray, Department of Chemical Pathology by February 15, 1955

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

Principal H Baker Ph D, A M I C E, A M I Mech E

Applications are invited for the post of Lecturer in Textile Chemistry and Dyeing Applicants should possess a degree or other high qualifications in pure or applied chemistry Experience in the Dyeing or Printing of Textiles will be an advantage, as will also be the ability to initiate and direct research Salary, £965 by £25 to £1,065 per annum

Further particulars and form of application may be obtained from the Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham, to whom completed forms should be returned not later than February 15 1955

F STEPHENSON,
Clerk to the Joint Education Committee

UNIVERSITY OF ABERDEEN

Senior Technician required for Clinical Chemistry Department, Foresterhill Wage on scale £460 by £20 to £560 placing according to qualifications and experience

Applications in writing to the Secretary, Marischal College

ENGINEER WITH CONSIDERABLE mathematical ability required at Ministry of Supply Experimental Establishment, Christchurch, Hants, for design and testing of mechanical and structural components including strain gauging Should possess first- or second-class honours degree in engineering and be proficient in strength of materials and theory of structures Corporate Membership of Institution of Civil Engineers desirable Salary within Scientific Officer range £467 10s to £845 Women somewhat less F S S U benefits may be available—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street London S W 1 Quoting E/30/5/A

READER AND SENIOR LECTURERS OR Lecturers in Physics—The Dean, College of Arts and Science, Baghdad, Iraq

NATIONAL RESEARCH COUN CANADA

Applications are invited for the post of Physiologist in the Division of Applied Bio Ottawa Duties Fundamental research on lems of photosynthesis and related metabc translocation, tissue culture or cell physiolog be carried on independently and in collabor with others Candidates must have at least years' experience beyond the doctorate lev plant physiology, plant biochemistry or cyt (other than cytogenetics) Initial salary wi in the range of $5,750 to $7,000 per annum pending on qualifications and experience, salary increases within this range for satisfa service Superannuation benefits, sick leave annual leave with pay apply, group hospital medical plans are available Duties to comm as soon as possible Applicants should Canadian or British subjects

Apply to the Director, Division of Ap Biology, National Research Council, Ott Ontario, Canada, giving full name, date of marital status, dependants, particulars of e tion, experience and interests, references to p cations, or, preferably, reprints and the n and addresses of three referees having int knowledge of their work

NORTHERN IRELAND HOSPIT AUTHORITY

APPOINTMENT OF NON-MEDICAL BIOCHEMIST

The Authority invite applications for the of Biochemist (non-medical) with duties at Central Laboratory, 51 Lisburn Road, Be The appointment will be in the grade of Scie Officer (Senior Grade) at a salary at the ra £835 by £40 (5) by £25 (1) by £20 (1) to a mum of £1,080 per annum Candidates sh possess an honours science degree of a unive of England, Wales, Scotland or Ireland, or suitable higher degree

Application forms and further particulars be obtained from the Secretary, Northern Ire Hospitals Authority, 44-46 Queen Street, Bel to whom completed applications should be to arrive not later than March 15, 1955

ROTHAMSTED EXPERIMENT STATION

HARPENDEN, HERTS

Chemists required in the Biochemistry De ment, to help in research on the formatio heterocyclic compounds in plants The app ment will be in the grade of Scientific O (£467 to £845) Starting pay according to qualifications experience and period of Nat Service The rates for women are some lower F S S U

Apply in writing to the Secretary, giving particulars and the names and addresses of referees

BRISTOL EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY

Principal G H Moore, M Sc F P S, F R

Applications invited for post of Head of De ment of Pharmacy as from September 1, Applicants should be graduates in pharmacy hold the Pharmaceutical Chemists' Dipl Salary Grade III Burnham Technical R (£1 215 by £25 to £1,365)

Further particulars and application forn be returned by March 5) from Registrar, C of Technology, Unity Street, Bristol, 1

Chief Education Offic

SCOTTISH MARINE BIOLOGIC ASSOCIATION

SECRETARY AND DIRECTOR

The Council of the Association invite ap tions for appointment to the combined offi Secretary of the Association and Director o Marine Station, Millport, as from April 1,

Particulars may be obtained from, The tary, Marine Station, Millport Isle of Cum Scotland

---

NATIONAL INSTITUTE FOR RESEA in Dairying requires Personal Assistant (fe to Head of Physiology Department Good tarial qualifications essential Degree in logical science or some biological exper would be an advantage, as would some k ledge of foreign languages Commencing according to age in scale £382½ (age 2 £482½ (age 26 or over on entry) to £540 (mum), with superannuation—Applications, names of two referees, to reach Secretary o Institute, Shinfield, Reading, within one Quote reference 55/3

MEDWAY AND GRAVESEND HOSPITAL MANAGEMENT COMMITTEE

RADIOTHERAPY CENTRE
WILLIAM'S HOSPITAL, ROCHESTER, KENT

HOSPITAL PHYSICIST

plications are invited from experienced Hos- Physicists for the post of Physicist, Senior e, to the above new Radiotherapy Centre y grade £835 to £1 080 per annum

ply, stating age, qualifications and experi- with two names for reference, to the Group tary, 20 Star Hill, Rochester, as soon as ble

---

UNIVERSITY OF TORONTO

PARTMENT OF CHEMICAL ENGINEER- ING AND APPLIED CHEMISTRY
CHEMICAL ENGINEER—PHYSICAL CHEMIST

ere is an opening on the professorial staff a chemical engineer well grounded and in- ted in physical chemistry, or a physical ist who has an engineering background arch interests or experience in the field of leum are highly desirable

dress inquiries to R R McLaughlin

CHNICIAN REQUIRED FOR TEACH- aboratory Sound knowledge of routine bio- ical technique essential and preference given older of intermediate I M L T certificate or alent Salary on scale £315 to £450 per m Post permanent and pensionable —Apply g particulars of experience to Administrative er, Department of Biochemistry, South Parks l, Oxford

---

UNG LADY GRADUATE (B A OR B SC) red for post of Cytologist in Tissue Culture ratory Knowledge of tissue culture tech- not essential, training provided Appoint- offers security, with opportunity of a good r Income according to individual initiative position is pensionable —Write giving details ge and education to the Director, Canine arch Station, Kennett, Newmarket, Suffolk

---

BORATORY TECHNICIAN, FULLY ed in physiological techniques, required e in accordance with university scale —Appli- n, in writing with the names of two referees, Administrative Officer, Sir William Dunn ol of Pathology, University of Oxford

---

CHNICIAN REQUIRED, EXPERIENCED iochemistry or chemical pathology —Apply iting to the Dean, St Thomas's Hospital cal School, London, S E 1

PPOINTMENTS VACANT

SECRETARY-LIBRARIAN

ung lady, competent shorthand-typist, red as Secretary to Research Depart- engaged in nutrition research, and also e responsible for the departmental library knowledge of science is essential and some y experience would be an advantage Five- week, starting salary £400 to £500 per m, according to experience

ply in writing, giving age and full details of ous experience, to Research Department, l Limited 148 Old Street E C 1

INFORMATION OFFICER

Applications are invited for the post of formation Officer with an Engineering ompany The responsibilities of the In- rmation Officer will include the organiza- on and operation of a Technical Library, stracting and compilation of biblio- aphies for senior technical staff engaged development and design work

Applicants should hold a science degree d preferably have had previous experience similar work Knowledge of languages advantage

Applications, giving full details of qualifi- tions, experience, age and salary required Box 642, T G Scott and Son, Ltd , 143- 7 Regent Street, London, W 1

TENT AGENTS IN LONDON REQUIRE tant with knowledge of chemistry (preferred) physics or of engineering Previous experi- in patent work would be useful but not tial The profession offers good prospects — y with particulars and salary required to 640 T G Scott and Son, Ltd , 143-147 nt Street, London, W 1

DISTILLERS COMPANY LIMITED

Applications are invited for the following appointments in the Industrial Group of the Company

SENIOR CHEMIST/CHEMICAL ENGINEER to supervise the operation of the Pilot Plant Division of the Research Department of British Industrial Solvents at Hull The Division includes chemists, chemical engineers, several teams of pilot plant operators, draughtsmen and a small workshop Age up to 37/38 years A degree in Chemistry or Chemical Engineering is essential, together with a number of years' experience of pilot plant work

ASSISTANT WORKS CHEMIST to undertake control work in the Company's Industrial Alcohol Distillery at Hull Age up to 26 years A degree in Chemistry or equivalent qualification is required, but similar work experience is not essential

ANALYST aged 30-40 years for analytical work in connection with the manufacture of whisky, its by-products and malt extract Duties will include the supervisior and training of young chemists in this field A degree in Chemistry or equivalent qualification is necessary and appropriate experience in general analytical and bio-assay work is desirable The post is tenable near Stirling in Scotland

Salaries for the above posts would depend on qualifications and experience Apply Staff Manager, The Distillers Co Ltd , 21 St James's Square, London, S W 1 Ref DCL/G2

A PHYSICIST WITH INDUSTRIAL EXPERIENCE of Instrument development is required to join a small team engaged in the design and manufacture of special-purpose apparatus The work is concerned with a wide variety of physical principles and manufacturing techniques A man possessing a general science degree, preferably including chemistry and with practical experience of mechanical and electrical engineering would be suitable The appointment is at the Applicational Research Centre of a Major Oil Company located near Chester Starting salary according to age, qualifications and experience Attractive pension benefits —Write, giving full details experience, qualifications, age, marital status, to Box ZT 705 Deacon's Advertising, 36 Leadenhall Street, London, E C 3

CHIEF CHEMIST REQUIRED BY FIRM specializing in the rare metals to supervise both routine and research laboratories Ph D or equivalent degree with some industrial experience Commencing salary £1,500 per annum Contributory pension scheme —Box 636, T G Scott and Son, Ltd , 143-147 Regent Street, London W 1

BRITISH NYLON SPINNERS, LIMITED The Company's expanding activities will give rise to further appointments, during the next few months, covering a wide field of scientific endeavour Graduate Scientists and Textile Technologists, whether available now or later, are invited to register their interest at this stage, and where necessary exploratory interviews will be arranged involving no obligation The openings will cover a range of work including pure research, applied research plant experimentation and the development of new manufacturing techniques up to full scale operation For men with suitable ability and inclinations there will be opportunities for specializing in the new advanced forms of technology arising with the advent of synthetic fibres and their textile applications Several of the appointments will be at a senior level and the Company will welcome tentative inquiries from chemists, physicists and textile graduates —These will be treated in strict confidence and should be addressed to the Personnel Manager, British Nylon Spinners Limited, Pontypool Mon

---

CHEMIST/PHYSICIST REQUIRED FOR RESEARCH Laboratory to work on interface phenomena in all its aspects We have a wide field of interests including surface area of small particles and fibres, electro kinetic effects, stability of emulsions etc The post is progressive and salary will be commensurate with ability —Full details to Chief Chemist, T B Ford, Ltd , P O Box 1, Snakeley Paper Mill, Loudwater, High Wycombe, Bucks

---

RESEARCH FELLOWSHIP

The Uganda Development Corporation, Limited, invite applications for a Research Fellowship, tenable for three years at the Building Research Station, Watford The successful candidate will be required to undertake fundamental research into problems of cement manufacture involving unusual raw materials, the methods employed being those of high temperature chemical and mineralogical investigation Applicants should be not more than 30 years of age, and should have an honours degree and have specialized in chemistry, physics or mineralogy Some research experience preferred Starting salary £700 to £900, according to experience and qualifications

Applications should be made in writing to J L Leyden, Esq , C B E , London Director, 27 Regent Street, S W 1, from whom further details can be obtained

---

RESEARCH LABORATORIES OF A MAJOR oil company have a vacancy for a first-class electronics engineer The position, which is a new one, involves the establishment of maintenance procedures for modern analytical instruments and the design and application of control instruments for pilot plant, test engines and analytical work Applications for this position are invited from first- or upper second-class honours graduates in physics, chemical or electrical engineering who have had a minimum of five years' experience in the application of electronics to industrial and/or laboratory instrumentation The salary offered will to some extent be dependent on the qualifications of the successful candidate, but it will be at a level commensurate with the responsibilities of the job The position is permanent and pensionable —Write in first instance to Box 643, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1, giving brief details of education and experience

---

THE ENGLISH ELECTRIC COMPANY INvites applications for the post of Technical Librarian at the Guided Weapons Division, Luton Applicants should hold recognized librarianship qualifications, have some scientific or technological background and have had responsible experience in a technical library Educational qualifications in physics or engineering approximating to a degree standard would be an advantage The salary will be in accordance with qualifications and experience —Applications to Dept C P S , 336-7 Strand, W C 2, quoting Ref 1378

DENIS FERRANTI METERS LIMITED, Bangor, North Wales Attractive vacancies occur in company situated in North Wales coastal town for engineers and physicists to work on interesting development projects Experience on optical devices, electro-magnetic equipment or electronic instrumentation, and degree or higher national certificate desirable A vacancy also exists for an industrial statistician to plan experiments and interpret data obtained in research work Assistance may be given in obtaining accommodation Good prospects in rapidly expanding organization —Applications, in confidence, to Chief Engineer

---

GRADUATE CHEMIST, METALLURGIST or Chemical Engineer required, to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel —Apply Electro-Chemical Engineering Co , Ltd , 161 Queens Road Weybridge Surrey

---

PROGRESSIVE SOUTH AFRICA PHARMAceutical Company requires senior pharmacologist with bacteriological experience —Inquiries and applications to Saphar Laboratories, P O Box 256, Johannesburg Selected applicants will be interviewed in London

---

FISONS PEST CONTROL, LIMITED, CAMbridge, has vacancies in Chemical Division for Chemists to originate and develop new manufacturing processes for organic chemicals Initial salary range £550 to £800 per annum, according to age, qualifications and experience Permanent, progressive positions Good canteen facilities Lodging accommodation available —Write (quoting No 1004), stating age, fullest particulars and salary required, to Personnel Manager, Fisons Pest Control, Ltd , Bourn, Cambridge

---

CHEMISTS AND PHYSICISTS REQUIRED for the preparation and evaluation of luminescent materials for use in a new project Men of graduate standing with relevant experience are needed Salary in accordance with qualifications Location near Northampton —Box 641, T G Scott and Son Ltd 143-147 Regent Street, London, W 1

ENGINEERS and PHYSICISTS

are required by BRITISH TELECOMMUNICATIONS RESEARCH LTD for work on long term research and development projects in the following fields —

(a) Wide-band line communication systems
(b), Wide-band microwave radio systems, including aerials and propagation
(c) Point-to-point television transmission systems
(d) Measuring and testing equipment for the above
(e) Magnetic materials and semiconductors

Attractive posts are offered to qualified engineers with experience in any of the above fields, and further vacancies exist for junior engineers and technical assistants.

The Company operates a superannuation scheme, and offers attractive working conditions with generous holiday and leave arrangements, and good social and recreational facilities.

All applications will be dealt with in confidence and should be addressed to the Director of Research, British Telecommunications Research Ltd , Taplow Court, Taplow, Bucks

MULLARD RESEARCH LABORATORIES

invite applications from Scientists to wor in its Vacuum Physics Laboratory Th posts provide opportunities for physicists physical chemists to carry out original r search in the field of surface effects in hig vacuum

Some of the vacancies are for seni scientists with previous research experien in mass spectrometry, gas-solid sorptic problems, or in some allied field

The work offers considerable individu responsibility and opportunity for origin research, and whenever possible, publication is encouraged

Salaries according to age, experience an qualifications Excellent conditions of employment, including contributory pensio scheme Apply, quoting reference V P I (R), to Mr G A Taylor, Personnel Manager, Mullard Research Laboratories, Cros Oak Lane, Salfords, near Redhill, Surrey

MULLARD RESEARCH LABORATORIES

invite applications for two types of permanent positions in its Vacuum Physics Laboratory In both cases, the work involves research and development in the realm of semi-conductors, solid state physics and photo devices

(a) SENIOR PHYSICISTS to act as Group Leaders with several years of academic or industrial research experience, preferably, but not necessarily, in the above fields

(b) PHYSICISTS with honours degrees, to work in research and development teams—with or without previous experience

In both cases the positions offered are progressive and pensionable, and carry attractive salaries Candidates, free of national service obligations, should apply, quoting reference V P L (J),

to Mr G A Taylor,
Personnel Manager,
Mullard Research Laboratories,
Cross Oak Lane,
Salfords, near Redhill, Surrey

A VACANCY FOR A YOUNG MALE science graduate exists in the laboratories of the Research Association of British Rubber Manufacturers Candidates should possess a pass degree in the physical sciences The person appointed is required to assist in technological investigations in the laboratories and must be prepared to spend time away from the laboratories carrying out investigations in rubber factories The appointment will be initially on the Technical Officer Scale (£475 by £25 to £675), with expectation of promotion to Senior Technical Officer (£600 by £30 to £870) Candidates already having industrial or other experience will be considered appropriately The post would be eminently suitable for someone wishing to familiarize himself with industry and gain experience before taking an executive industrial position —Applications, giving full particulars of age, qualifications and experience, to be sent to the Secretary, RABRM, Shawbury, Shrewsbury, Shropshire

CHIEF CHEMIST WM MOORHOUSE & Sons Ltd Sunglow Model Factory Leeds require Chief Chemist experienced in Preserves or Food Industry, able to take full analytical and quality control Main specialities Jams, marmalades, lemon curd Christmas puddings mincemeat, bottled and canned fruits, jellies This is a senior appointment and carries non-contributory pension —Apply giving full details present appointment past record, salary required etc , to Managing Director All applications treated in strictest confidence

PHARMACEUTICAL RESEARCH CHEMIST A well qualified chemist or pharmacist, experienced in research methods, is required by London firm of manufacturing chemists to carry out interesting research relating to the development of pharmaceutical products Postgraduate research experience would be considered an advantage This is a responsible post, carrying a good salary and there is a pension scheme —Applications will be treated in strictest confidence and should give full details of age, qualifications and experience Please address to Box 637, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1

QUALIFIED ELECTRICAL ENGINEER OR Physicist required for work on the design and utilization of rubber cables for a wide variety of applications, mainly for power distribution in coal mines, aircraft, ships, etc The position offers good opportunities for further advancement —Apply Box 632, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1

GRADUATES WITH HONOURS DEgree are required by the BTH Co , Rugby, for research into the physics of light emission from electric discharges and from incandescent surfaces The work will involve radiation measurement and the experimental development of new light sources —Applicants should write to the Director of Research, British Thomson-Houston Co , Ltd , Rugby, giving their age, qualifications and college, quoting reference RH

APLIN AND BARRETT, LTD , REQUIRE A Bacteriologist for their Research Laboratories at Yeovil Applicants should hold a degree in bacteriology and chemistry, and some research experience would be an additional qualification The person appointed would be required to undertake fundamental research in addition to work of a more applied nature Salary according to age, qualifications and experience —Applications should be addressed to The Director of Research, Aplin and Barrett, Ltd , Newton Road, Yeovil, Somerset

APPLICATIONS ARE INVITED FOR SCIENtific Officers for the British Steel Castings Research Association, Broomgrove Lodge, Sheffield, 10 Posts vacant for candidates with either metallurgical or engineering bias to their training Acquaintance with foundry practice a recommendation This Association is building a new experimental station Prospects good for future progress Salary according to qualifications and experience Usual professional qualifications expected

MONKHOUSE AND GLASSCOCK, LTD , Snowsfields, London, S E 1, manufacturers of "Monk and Glass" food products, have a vacancy for a chemist, preferably not more than 30 years of age A good degree and experience with foodstuffs are required The successful candidate will be in immediate charge of control and development work under the Chief Chemist The initial salary will depend on qualifications and experience There is a staff pension scheme —Applications, giving full details of career, etc should be addressed to the Chief Chemist

ANALYTICAL CHEMIST REQUIRED firm of manufacturing chemists for the contr quality of pharmaceutical products and their materials and for the development of analy processes for the standardization of new prod Well equipped laboratory in N W Lon Commencing salary £750 to £800 Contribu pension scheme —Please address applicat which should state age, qualifications, experi etc to Box 633 T G Scott and Son, Ltd , 147 Regent Street London, W 1

DEVELOPMENT ENGINEERS MARCO Wireless Telegraph Co Ltd , Chelmsford, the following appointments to the perma technical staff of the Company These are paid responsible positions suitable for applic possessing design and development experienc the following fields

Ref 2120 AIRCRAFT AERIALS Expe mental design and development of H and V H F Aerials Systems Applica should have had some experience in t field and preferably be familiar with sm scale model techniques

Ref 2130 RADIO LINKS Appointme are in connection with the development U H F and S H F Wideband Multichan systems Especially suitable for applica with a knowledge of travelling wave tub and centimetric techniques

Ref 2140 MARINE COMMUNICATIO AND RADAR Appointments availa in connection with the development marine transmitters, receivers, navigatio aids and associated equipment

Ref 2220 T V EQUIPMENT Vacanc exist in connection with the development cameras, studio equipment, transmitters a associated apparatus

Ref 2240 V H F MOBILE EQUIPMEN Appointments available in connection w the design of mobile transmitters, receiv and associated power supplies

All appointments are in connection with th pansion of activities in the Company and excellent career prospects for applicants wh able to make an immediate contribution to work of the Groups Please write giving details of qualifications and experience quoting ref SA 55A and appropriate refe number, to Dept C P S 336/7 Strand, W

PHYSICAL CHEMIST (OR PHYSIC with knowledge of analytical methods) to charge of Works Control Laboratory in Hert shire, graduate preferred Initial salary app mately £1 000 per annum (according to qual tions for post) Excellent prospects Pension profits participation schemes —Write full d age qualifications experience to date, to P C Box No 8282, c/o Charles Barker and Ltd , 31 Budge Row London, E C 4

TECHNICAL DEVELOPMENT

Opportunities exist for graduates to enter n expanding and interesting field of work

Appointments are to be made in both enior and intermediate capacity on the staff f a Development Group engaged on proects entailing a special knowledge of and iterest in thermodynamics and physical iemistry

Applications are invited from

1 Graduates with a good science degree and at least four years' research or development experience and being within the age group 27-35 Commencing salary from £1,000 per annum, according to experience and ability

2 Graduates with a good science degree and within the age group 21-26 Previous experience is not essential and graduates due to complete their National Service within the next twelve months are also invited to apply Commencing salary from £650 per annum

Applications should be addressed to Box 9, T G Scott and Son Ltd, 143-147 egent Street, London, W 1, and give llest possible information of qualifications d experience

SIERY AND ALLIED TRADES RESEARCH ASSOCIATION

plications are invited for the post of Librar- Applicants should possess a good scientific technical training and should for preference a science degree A knowledge of library nization and abstracting will be an advantage ications will be considered from either men omen The initial salary in accordance with fications will be not less than £500 per n

rther details and forms of application can be ned from the Secretary, Thorneywood House rst Avenue Sherwood Rise Nottingham pleted forms should be returned not later February 28, 1955

ITISH CELLOPHANE, LTD BRIDG-, Somerset, invites applications for the folg posts Research Chemist Male graduate, 20 to 40 The post is concerned with the ion of compounds for milling and calanderf polymers for plastic films Please quote No R37 N Research Physicist Male ate, age 20 to 40 The duties involved will poratory experimental work on the properties ises of packaging films Please quote Ref R38 N There is a contributory pension scheme—Five-day week—Applications l be addressed to the Personnel Officer, statialifications experience and salary required, uoting appropriate reference number

---

ADING OIL COMPANY HAVE cy for Chemist in their Head Office Applishould be in possession of degree or equi-, and if possible wide experience in the eum industry Work to cover lubricants, ts, bitumens, fuels, etc Age 30 to 35 Salary according to age and qualifications plicants should apply giving full particulars alifications and experience, quoting H 3115, x 7267 c/o 191 Gresham House E C 2

NAGERIAL POSITION OFFERED IN . to Chemical Engineer with several years' rial experience in natural products extrac- Must be able to develop and maintain services and control labour Salary accord- qualifications and experience, home leave, n and bonus schemes—Applications in confidence to Box JA/148, c/o 95 Bishops-E C 2

ASSHOUSE CROPS RESEARCH INSTI- quire a Soil Microbiologist Good honours essential Appointment is Senior Scien-Officer or Scientific Officer grade, according e, qualifications and experience Salary (men) Senior Scientific Officer, £970 to , Scientific Officer, £467 to £845 Women's somewhat lower Superannuation under U—Applications with names of two s, should be sent to the Secretary, Glass-Crops Research Institute, Worthing Road, gton Littlehampton

---

OY CHEMIST, GRADUATE OR H N C, d for analysis of electroplating and allied ns—Apply, Electro-Chemical Engineering td, 161 Queens Road, Weybridge, Surrey

---

DISTILLERS COMPANY LIMITED

The Research and Development Department of the Company have a vacancy for a Mathematician aged 22-26 years for work on a variety of problems concerned largely with instrumentation and physical methods for the study of high polymers Honours degree in mathematics essential, together with some general knowledge of physics, including electronics Salary would depend on qualifications and experience—Apply Staff Manager, The Distillers Co Ltd, 21 St James's Square, London, S W 1 Ref Res 155

MATHEMATICIANS ARE OFFERED good prospects in the Aircraft Industry

SHORT BROTHERS AND HARLAND LIMITED, have vacancies for honours graduates in mathematics in the Analytical Section of the Research Group for initial project and analytical work related to guided weapon and navigation projects, gyroscopic systems, analogue computors, servos and aircraft control development

Experience in industry, the Technical Branches of the Service or in the Scientific Civil Service is essential Adequate experience would serve to make a pass degree acceptable

Assistance with housing and with removal expenses

The amenities normal in large and progressive companies are available

Applications giving relevant details to

Staff Appointment Officer, P O Box No 241, Belfast, quoting reference S A 28

PHYSICIST/ENGINEER OR ENGINEER/Physicist aged between 30 and 40 required to act as Assistant to the Head of the Research Department of a light engineering company with its headquarters in South London Ample modern technical resources are available and the company spends large sums on research and development work Applicants should possess a good degree, a sound engineering background and experience both of controlling a scientific staff and of winning their confidence Starting salary will not be less than £1,200 per annum and a contributory pension scheme is operated—Applications, which will be treated in strict confidence, should contain details of age, experience, qualifications and present salary, and be addressed to Box 808, c/o J G King and Son 150 Fleet Street, London, E C 4

FOOD CHEMIST REQUIRED TO HEAD the analytical laboratory of a London factory manufacturing biscuits, wafers and chocolate A really practical man is sought, keen to see his work intimately linked to production Applicants should have experience in cereal chemistry or chocolate manufacture in addition to a sound knowledge of food analysis Commencing salary is £1,000 per annum and the prospects are excellent Contributory pension scheme, five-day week—Reply with full details of academic and industrial background, to Box N 821, c/o 191 Gresham House E C 2

STATISTICIAN REQUIRED FOR OPERAtional Research into production control problems of a large steelworks in the Sheffield area The work involves variance analysis, etc, of machine behaviour, set in the study of stochastic processes of flow A knowledge of queue theory is desired and the ability to handle time series including auto-correlation The applicant should be interested in the Monte Carlo treatment of synthetic data and in such economic developments as game theory, activity analysis, and linear programming He/she will probably hold or be about to gain a degree in mathematical statistics, and should apply in fullest detail (referring to breadth of interests and stating salary expected) to the Production Control Officer, Box 629, T G Scott and Son Ltd, 143-147 Regent Street, London, W 1

AN ORGANIC CHEMIST IS REQUIRED BY British Schering Manufacturing Laboratories Ltd, Hazel Grove, Cheshire, to take charge of a small Development Laboratory The position would suit a university graduate with two or three years industrial experience A salary of not less than £700 per annum will be paid, according to qualifications and experience

---

GRADUATE CHEMIST

required for work on Power Cables Experience in the field of Plastics would be a distinct advantage Salary fully commensurate with qualifications and experience Applications, giving full particulars of qualifications and experience to Employment Manager, Messrs Johnson and Phillips Limited, Victoria Works, Charlton, S E 7

UNICAM INSTRUMENTS, LTD

Applications are invited from electronic engineers for positions in the development and inspection departments of Unicam Instruments of Cambridge This company is engaged in the manufacture of important instruments, combining original optical and electronic design, which are much in demand for academic and industrial research and process control the world over Good salaries according to qualifications will be paid—Applicants should send full details of age, education and experience to the Personnel Manager Unicam Instruments Ltd, Arbury Works Cambridge

---

THE INDIAN TEA ASSOCIATION REquire two Agricultural Advisory Officers for their Experimental Station in Assam and subsequent location in the tea districts Candidates for appointment must have good degrees in agriculture or good honours degrees in pure science (Undergraduates in their final academic year may apply, any appointment made being in this case, conditional on success in the final examinations) Preference will be given to candidates who can provide evidence of suitable postgraduate training or experience in agriculture but candidates without such experience will be considered if other qualifications are of the appropriate character and standard The successful applicant may be required at the option of the Association, either first to undertake one year's postgraduate training in the United Kingdom at the expense of the Association, or to proceed to India immediately on appointment An officer proceeding to India immediately on appointment may be required, at the option of the Association, to undertake one year's postgraduate training in the United Kingdom at the expense of the Association either during or at the end of the first agreement, which will be for three years The salary scale on appointment will be Rs 900 (£67 10s) per month, rising by annual increments to Rs 2,300 (£172 10s) per month after 21 years' service In addition, servants, car, entertainment and cost of living allowances amounting to Rs 600 (£45) per month for single men and Rs 850 (£63 15s) per month married men are given, with free partially furnished bungalow accommodation There is a provident fund and pension scheme Leave of seven months after the first three years' service and of four months every two years thereafter is granted on full pay and allowances (excluding car and entertainment allowances) and with passages to the U K—Applications, giving full details of academic career and three testimonials, should be sent to the Secretary, Indian Tea Association (London), 39, Lombard Street, London, E C 3, not later than February 28, 1955

JOSEPH LUCAS, LIMITED, HAVE AN INteresting vacancy in their research and development laboratories which would be suitable for a young graduate with honours degree in mathematics or physics The work is largely of a fundamental nature and is concerned with acoustics and mechanical vibrations Previous industrial experience is not necessary—Please reply giving qualifications, age, and any other relevant details, to Personnel Manager, Joseph Lucas (Electrical), Ltd, Great King Street, Birmingham, quoting reference PM/D/59

AFRICAN EXPLOSIVES AND CHEMICAL Industries Limited, South Africa, has a limited number of vacancies in its Research Department near Johannesburg for Physical Chemists who have recently graduated with at least honours degree Remuneration will depend upon qualifications—Inquiries should be addressed to Mr R A Webb, African Explosives and Chemical Industries Limited, Imperial Chemical House, Millbank, London S W 1

QUALIFIED CHEMIST REQUIRED AGED 23 to 30 for engineering works in North-West London Interesting post for man with experimental outlook Superannuation B Sc or similar degree necessary—Reply with full details of age, experience, and salary required to Box 635, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

Advertisers please note You must add "Apply Employment Exchange" unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

MONSANTO CHEMICALS LIMITED REquire a Technician for electronic instrument development at the Nickell Laboratories, Ruabon Applications are invited from physicists, physical chemists or electrical engineers with experience in this field The work will be concerned with the development of new control and measuring devices for both research and production departments —Full details of age, education, training and experience should be sent to the Chief Personnel Officer, Monsanto Chemicals Limited, 8 Waterloo Place, London, S W 1

E M I ENGINEERING DEVELOPment Ltd, have a vacancy for an Assistant Librarian required in Technical Library at Hayes Not under 22 Educated up to Inter B Sc standard in physics and chemistry, and preferably having previous library experience, including cataloguing and indexing —Applicants should send full details to the Personnel Dept (ED/191), E M I Eng Dev Ltd, Hayes, Middlesex

RESEARCH CHEMIST, MALE, REQUIRED for physicochemical problems associated with fruit juices Candidates should be recent graduates or hold qualifications of a professional body and have had practical experience Must be prepared to live in small country town in Gloucestershire —Apply Personnel Manager, Box 631, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

YOUNG GRADUATE IN CHEMISTRY with physical or engineering bias required for research and development of new ceramic materials and technical control of production This is a new and interesting field offering good prospects Commencing salary in the order of £500 to £600 per annum, or more according to merit —Apply in writing to Neosid Ltd, Stonehills House, Welwyn Garden City, Herts

FOR SALE AND WANTED

CORNEAL AND CONTACT LENSES EASY payments arranged if desired —For details and free booklet write David Blackstone, Ltd, Dept 235, Triumph House, 189 Regent Street, London, W 1 Tel Regent 3516-7 Consulting Rooms in Leeds, York, Leicester, Middlesbrough Newcastle etc

FOR SALE CAMBRIDGE BENCH *p*H Potentiometer complete with accumulators and electrodes for *p*H 0-14 —Box 638, T G Scott and Son, Ltd, 143-147 Regent Street, London W 1

GRANTS & SCHOLARSHIPS

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH

Notice is hereby given that an election of Junior Fellows to begin work on October 1 next will take place in May, 1955 Junior Fellowships have successive annual values of £800, £850 and £900, for three years As a rule, superannuation benefits are provided, to which the successful candidates will be required to contribute 5 per cent of the annual stipend and to which the Trust will make a contribution of 10 per cent Candidates must have taken a degree in a faculty of a university approved by the Trustees in Her Majesty's dominions, Protectorates and Mandated Territories, India, Pakistan and the Republic of Ireland, or a medical diploma registrable in the United Kingdom Elections to Junior Fellowships are rarely made above the age of 35 years Applications from candidates must be received not later than April 1 Candidates must submit evidence that they can be given accommodation in the departments where they propose to work, which must be either in Great Britain or Ireland

Forms of application and all information may be obtained by letter only, addressed to the Secretary Beit Memorial Fellowships for Medical Research, The Lister Institute, Chelsea Bridge Road, London, S W 1 For overseas candidates forms of application may be obtained from the Secretary, South African Medical Council, P O Box 205, Pretoria, South Africa, the Director, Commonwealth Office of Education, Box 3879, Sydney, Australia, the Department of Health, Wellington, New Zealand, and the Canadian Medical Association, 184 College Street, Toronto, Canada

SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY

SCHOLARSHIPS

Applications are invited for Salters' Scholarships, value £350 to £500 per annum (plus university fees), according to circumstances, for a graduate resident in the United Kingdom with an honours degree in chemistry, biochemistry, physics or engineering, for the purpose of receiving either full-time instruction in the principles of chemical engineering or further experience by research in chemistry or chemical engineering in order to be better qualified to enter chemical industry The Scholarships will be tenable for one year

Applications should be received by the Clerk of the Salters' Company, 36 Portland Place London, W 1, by March 31, 1955 Applications may also be made at any time during the year, but any such late applications will only receive consideration if there are vacancies Applications may be made before graduation Forms of application may be had on request

SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY

FELLOWSHIPS

Applications are invited for Salters' Fellow
value £600 per annum (plus university fees
10 per cent contribution to F S S U) f
graduate with an honours degree in chem
biochemistry, physics or engineering in order
the appointed Fellow may obtain further tra
in research in chemistry, biochemistry or che
engineering, with a view to fitting himsel
a career in industrial chemistry and contrib
to the improvement of processes and produc
industry The Fellowships will be tenabl
one year from September 1, 1955, and rene
for one further year

Applications should be received by the
of the Salters' Company, 36 Portland Place,
don, W 1, by March 31, 1955 Forms of
cation may be had on request

THE ROYAL SOCIETY

ROYAL SOCIETY AND NUFFIELD FOUNDATION COMMONWEALTH BURSARIES

Applications are invited for awards unde
Royal Society and Nuffield Foundation Com
wealth Bursaries Scheme which was institut
provide facilities for increasing the efficienc
scientists of proven worth by enabling the
pursue research, learn techniques or follow
forms of study in natural science in cou
other than their own in the Commonwealth
the physical or personal environment or bot
peculiarly favourable The bursaries p
travel, maintenance at a rate of about £600 a
depending on living costs and the appl
circumstances and are tenable usually for p
of two to twelve months, they are not int
to provide any salary as such Bursars wi
be permitted to prepare specifically for, or t
examinations for, higher degrees or diplom

Fuller particulars and forms of applicatio
be obtained from the Assistant Secretary,
Royal Society, Burlington House, London,
Applications should be made before Marc
1955, for proposed visits beginning durin
period from July to December 1955

QUEEN ELIZABETH COLLE

(UNIVERSITY OF LONDON)

Applications are invited for two Postgra
Scholarships, value £350 to £400, for the s
1955-56, for research in chemistry, hou
science or physics

Particulars and application form from th
retary Closing date March 15

MISCELLANEOUS

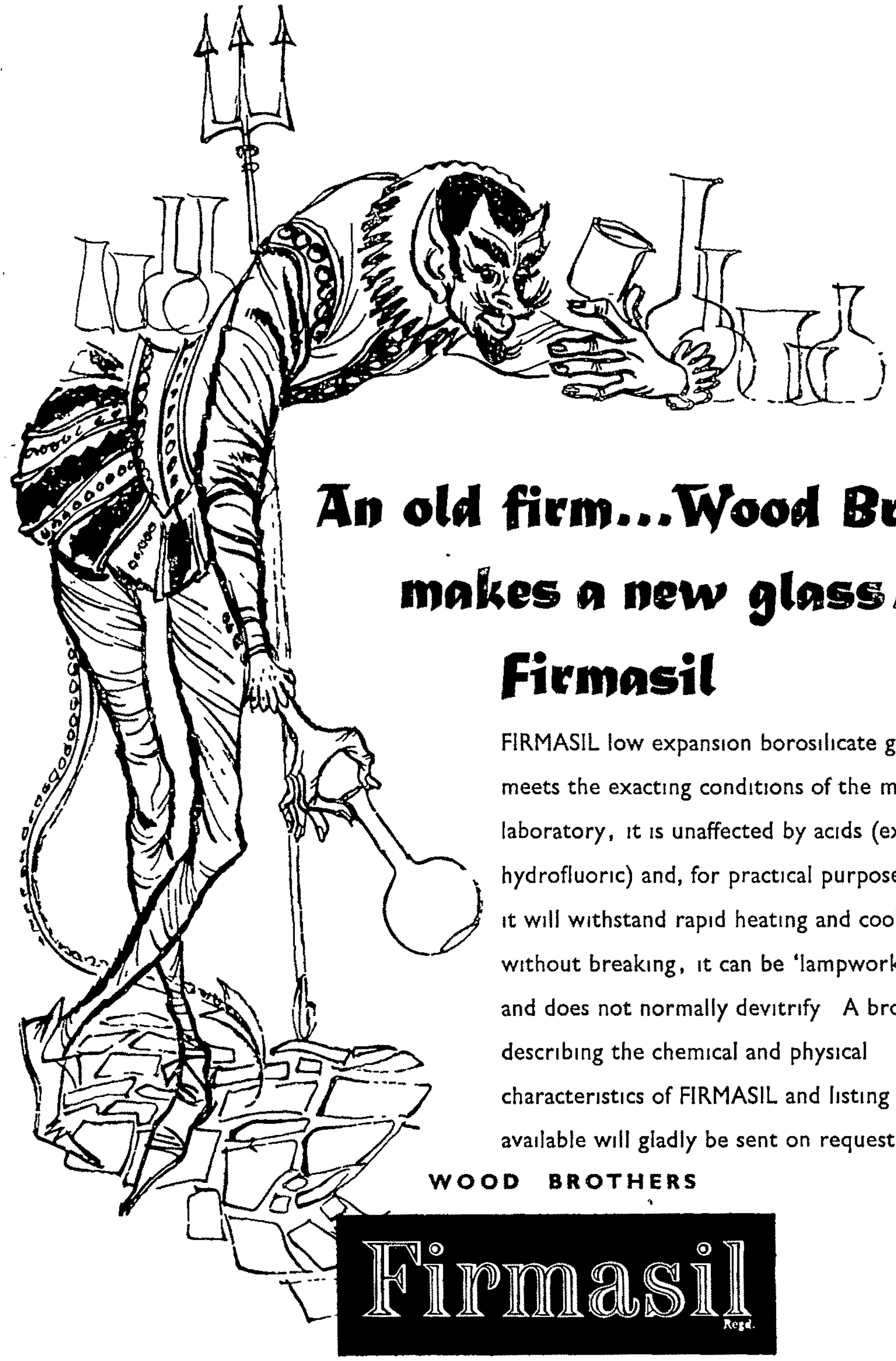
ELECTRONICS APPLIED TO INDUS
Learn the basic principles and applications
our modern self-study course Experi
work included if required —Free Brochure
E M I Institutes Dept N 56, London,
(Associated with H M V)

BRASS • COPPER • DURAL • ALUMINIUM • BRONZE •
ROD, BAR, SHEET, TUBE, STRIP, WIRE
3,000 STANDARD STOCK SIZES
No Quantity too small • List on application
H. ROLLET & CO., LTD.
6, CHESHAM PLACE, LONDON, S W 1. SLOane 3463
Also at LIVERPOOL, LEEDS, MANCHESTER, BIRMINGHAM

• Individually Tested and Guaranteed •
(A E R E Harwell approved)
HIGH VACUUM STOPCOCKS
New Catalogue on request to
G. SPRINGHAM & CO. Harlow New Town
"The Stopcock People" HARLOW 24108

PRESS for making
KBr and KCl DISKS
as used in I-R and U-V solid state study
INFRA-RED CELLS
Variable path-length cells for liquids
Fixed path-length cells for liquids and gases
(Made by Research & Industrial Instruments Co)
Catalogue CH388/N2 free on application from
HILGER & WATTS LTD.
98 St. Pancras Way, London, N.W.I

HIGH SPEED VIBRATION MILL
(100 *C P S*), ideal for KBr disk technique and other fine and fast grinding
ROTATING ELECTRODE (*graphite disk*) **SPARK UNIT** for the study of lubricating oils, other liquids and powders
Descriptive literature on application
RESEARCH & INDUSTRIAL INSTRUMENTS CO.
1 Laycock Street, Islington, London, N 1 ARChway 5488



An old firm...Wood Brothers makes a new glass... Firmasil

FIRMASIL low expansion borosilicate glass-ware meets the exacting conditions of the modern laboratory, it is unaffected by acids (except hydrofluoric) and, for practical purposes, by alkalis, it will withstand rapid heating and cooling without breaking, it can be 'lampworked' easily and does not normally devitrify A brochure describing the chemical and physical characteristics of FIRMASIL and listing the range available will gladly be sent on request

WOOD BROTHERS

Firmasil Regd.

RESISTANT GLASSWARE

Wood Bros Glass Co Ltd
Barnsley, Yorkshire

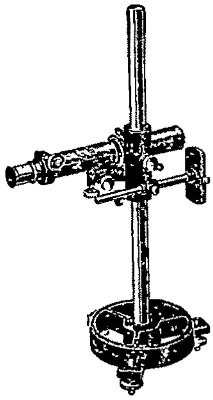
LARGE READING TELESCOPE

From Four Feet to Infinity

The Large Reading Telescope can be focused from 4 ft to infinity or down to approximately 18 in with a supplementary lens, and has a magnification of x 10 The micrometer eyepiece with a sighting cross line can be replaced by an eye piece with a 100-division scale

Price (Telescope and Stand) £21

Please write for further details to



C. Baker OF HOLBORN LTD. EST. 1765

METRON WORKS · PURLEY WAY · CROYDON
Showrooms **244 High Holborn, London, W.C.1**

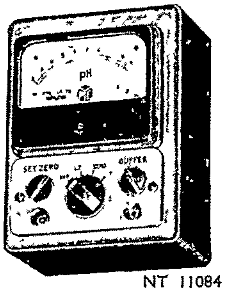
PHASE CONTRAST ILLUMINATION

A booklet fully describing the Beck Phase Contrast Illumination Apparatus will be forwarded on application

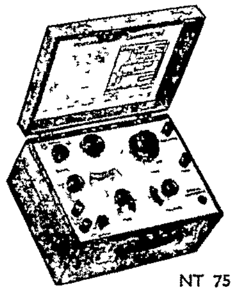
R & J BECK LTD
69 MORTIMER STREET
LONDON W 1

BECK LONDON

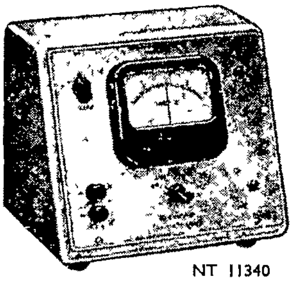
The following outstanding instruments ar now available . .



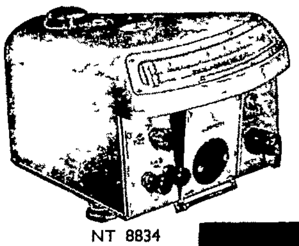
1 NT 11084



3 NT 7569/P



2 NT 11340



4 NT 8834

1 MINIATURE pH METER — for on-the-spot determinations in the plant or in the field and for routine laboratory measurements

2 SENSITIVE D C MICROVOLTMETER This portable instrument provides the sensitivity of a freely suspended reflecting galvanometer in a robust, compact form It also operates as a D C Amplifier with very low drift

3 PORTABLE POTENTIOMETER—a robust compact instrument suitable for both workshop and laboratory use

4 "SCALAMP" FLUXMETER provides exceptional performance, fitted with controlled return-to-zero device

Please write now for your copy of the new catalogue 'J'

Affiliated Companies —
Pye (Canada) Ltd , 60 Front St West, Toronto, Ontario, Canada
Electronic Industries Imports Pty Ltd ,
139, Bouverie St , Carlton, N 3, Victoria, Australia
Pye (N Z) Ltd , P O Box 2839, Auckland, New Zealand

SCIENTIFIC PYE INSTRUMENT

W G PYE & CO. LTD · GRANTA WORKS · CAMBRIDGE ENGLAN

Printed in Great Britain by FISHER, KNIGHT & Co , LTD , The Gainsborough Press, St Albans, and published by MACMILLAN & Co , LIMITED, at St Martin's Street, London, W C.2, and ST MARTIN'S PRESS, INC , 103 Park Avenue, New York 17, N Y , U S A —Saturday, February 5, 1955

NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye"—Wordsworth

PHYSICS LIBRARY
25 3 55

Vol 175, No 4450 SATURDAY, FEBRUARY 12, 1955 Two Shillings

THE Newton

LONG WORKING DISTANCE ATTACHMENT

provides a working distance of 12 8 mm between object glass and specimen when fitted to a standard microscope in conjunction with a conventional 4 or 8 mm objective

A further important feature is that the use of this attachment eliminates image reversal and thus further facilitates examination and manipulation of specimens.

Write for further details to Metropolitan-Vickers Electrical Co, Ltd, Trafford Park, Manchester, 17
Member of the A E I Group of Companies N/A 101

Tinsley

STANDARD CADMIUM CELLS

Single and double types in wooden cases or in metal cases as illustrated

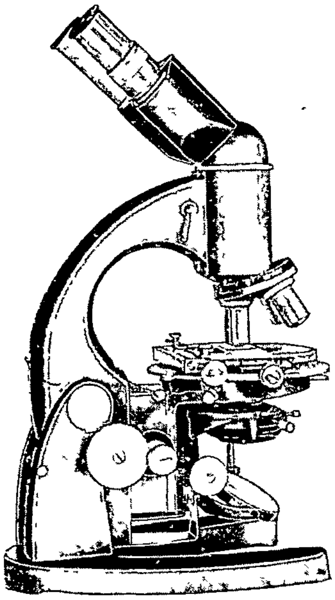
Reliable single or double miniature types mounted in plastic cases, E M F 1 01859 abs volts at 20° C Temp coeff —40 μV/1° C. Low internal resistance

Dimensions 3¼ in × 1⅝ in × 1$\frac{3}{16}$ in

Non-temperature coefficient cells for industrial use

All types of unmounted standard cells can be supplied in quantity from stock

H. Tinsley & Co., Ltd., Werndee Hall, London, S.E.25
Telephone : ADDiscombe 1400 and 3680



It's the ease of manipulation that counts . . .

. . allied, of course, with first-class optical equipment The Baker Series 4 Microscope, with its close-coupled controls placed in a natural position, and its excellent workmanship and finish, is an instrument with which you will be proud to work. Write now for details :

C. Baker OF HOLBORN LTD. EST. 1765

Metron Works · Purley Way · Croydon · Surrey (Croydon 6644/9822)
Showrooms : 244 High Holborn · London · WC1

EDWARDS – SAUNDERS

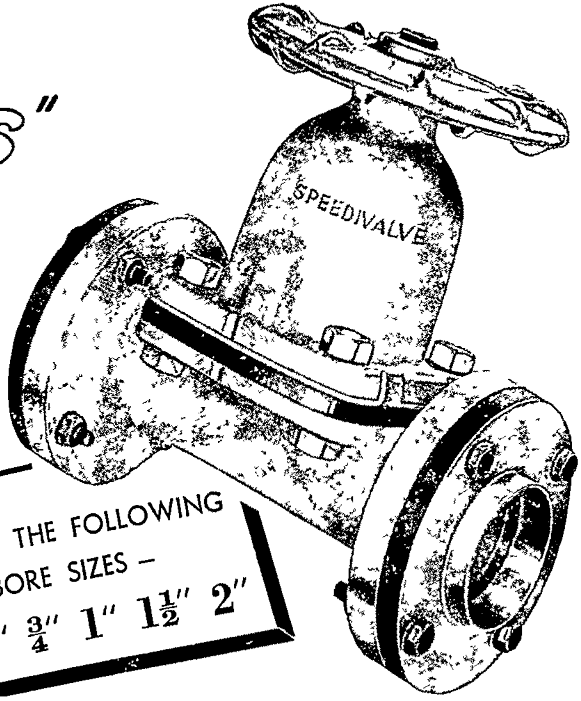
"SPEEDIVALVES"

Seal 'NOTHING' in, everything else OUT

When a high vacuum is sealed off nothing can get by the absolute vacuum-tightness of the 'SPEEDIVALVE' Designed by a team of well-known valve manufacturers in co-operation with our own vacuum technologists, these outstanding wear-resisting diaphragm valves achieve complete freedom from spindle leakage There are no moving parts to wear out and an unrestricted pipeline flow results when the valve is open

Valves up to 1 in. have integral EDWARDS RAPID-ASSEMBLY UNIONS WITH 'O' RING SEALS

The larger valves are specially flanged to receive 'O' ring type seals

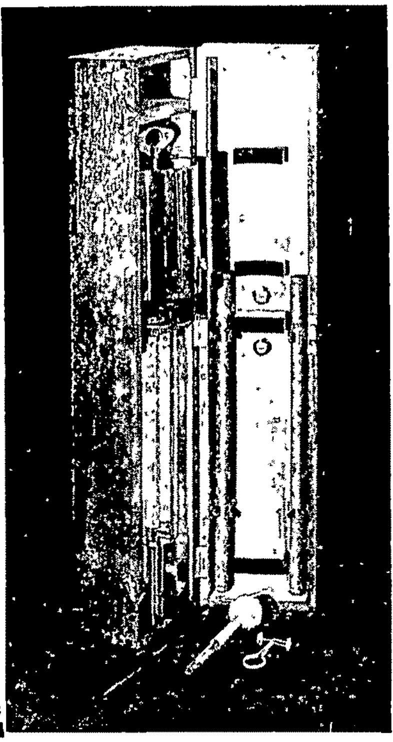


MADE IN THE FOLLOWING BORE SIZES –
¼" ½" ¾" 1" 1½" 2"

W. EDWARDS & CO (LONDON) LTD
for better vacuum service
MANOR ROYAL · CRAWLEY SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY
BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

CASELLA LONDON

ASPIRATED HYGROMETER



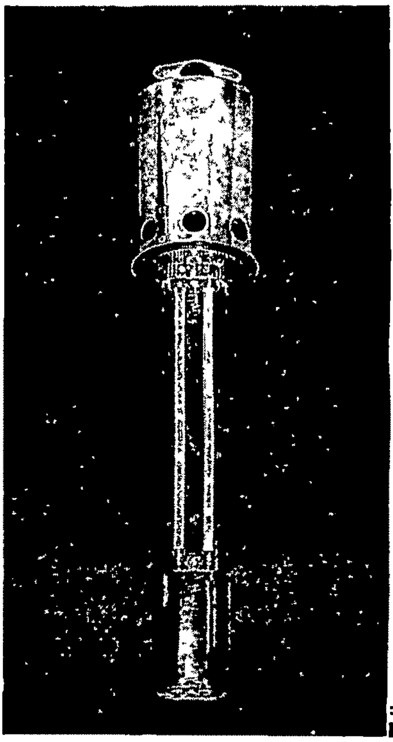
Improved patterns, as supplied to the British and other Meteorological Services. Powerful, clock-driven motor ensures full aspiration Frame for thermometer is now made of transparent plastic Electric drive available.

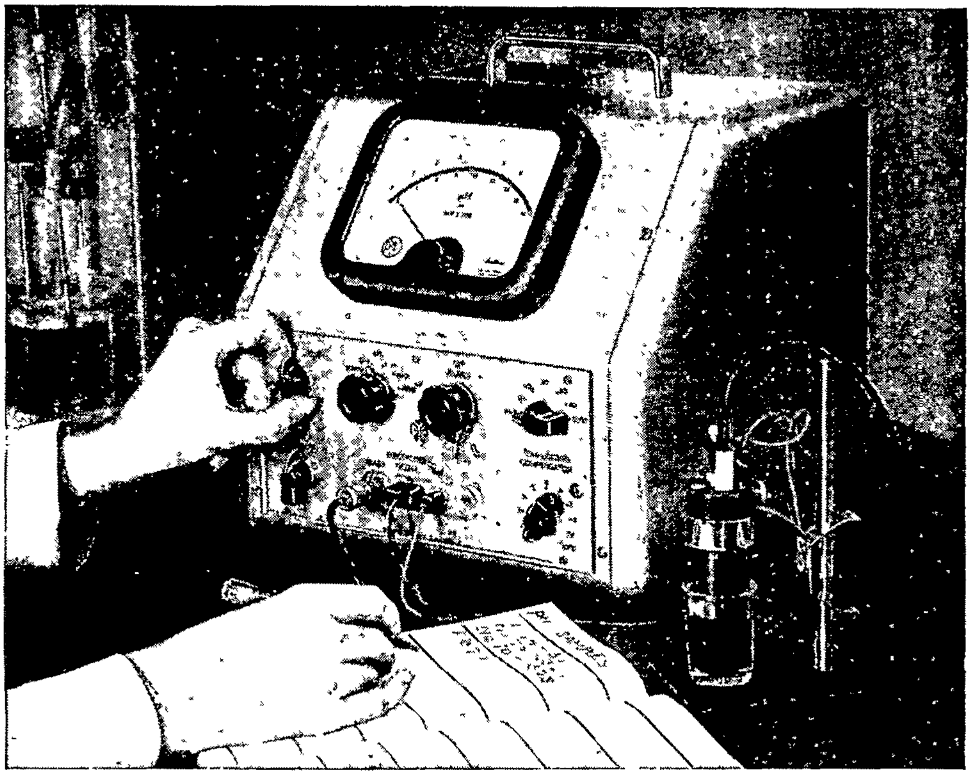
23 x 5½ x 5 in. (58 x 14 x 13 cm) 9¾ lb (4 4 kg)

This instrument can now be supplied from stock and further details may be obtained on request to

C. F. CASELLA
& CO. LTD.
REGENT HOUSE
FITZROY SQUARE
LONDON - W 1
Telephone ★EUSton 3944

Member Scientific Instrument Manufacturers' Association of Great Britain



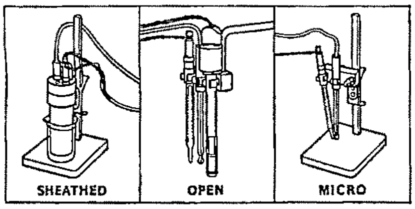


Ask users about the

PYE pH METER

AND MILLIVOLTMETER

DIRECT READING — MAINS OPERATED



Electrode Kit to make up all the assemblies illustrated and all necessary accessories are supplied complete with the instrument.

Many leading industrial laboratories are using the Pye Universal pH meter and millivoltmeter to their complete satisfaction. Read what The British Aluminium Company Limited says:

"... *we write to inform you that our recommendations for the purchase of a number of these equipments for use in our Routine Laboratories have been accepted. You can expect, therefore, within the next week or so to receive orders from a number of our factories. We feel you would like to hear from us this tangible proof of how satisfactory we found your instruments.*"

Signed Director of Research.

May we send you details of this and other instruments in our comprehensive pH range?

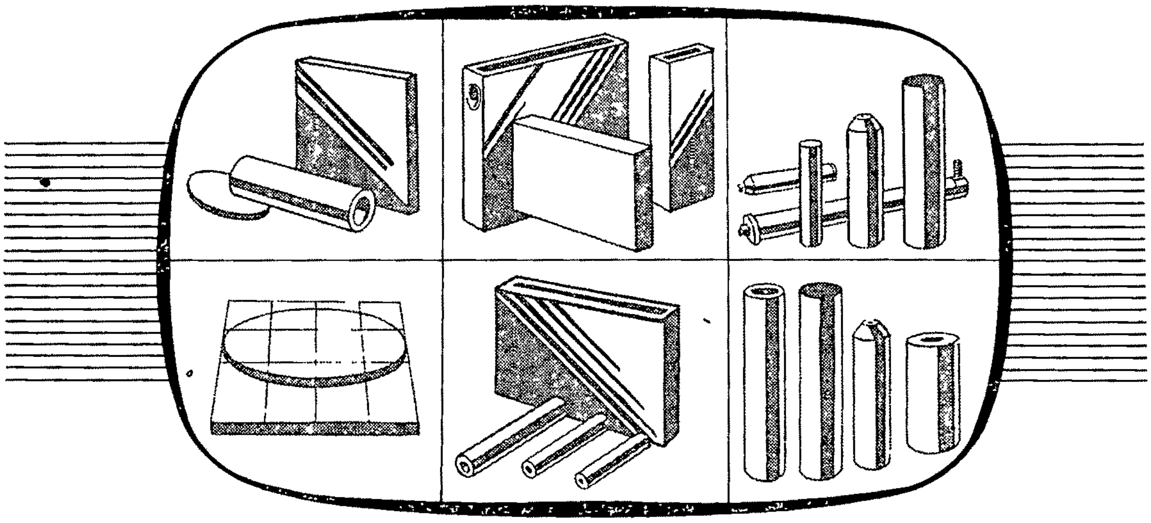
STANDARD EQUIPMENT IN MANY LEADING LABORATORIES

SCIENTIFIC PYE INSTRUMENTS

W G PYE & CO LTD, GRANTA WORKS, CAMBRIDGE, ENGLAND

W G 50

"Leaders in a Specialised Field"



The unique position occupied by Aerox Limited in the world of industrial ceramics is due to specialisation This company was founded essentially to manufacture and develop certain types of ceramic material to meet the needs of a growing complexity of industrial requirements

Although classed generically as "Porsilex", "Celloton", or "CorAlith" Porous Ceramic Media, many grades of material of different types and characteristics exist to meet the vast range of uses in air, gas and liquid filtration, diffusion, aeration and electrolytic separation encountered in modern plant, CorAlith being specially developed for maximum resistance to thermal shock

Complete Aerox Filter equipment is also available for air, gas and liquids up to pressures of 5,000 p s i

* In addition, Aerox Limited are sole world selling agents for Petrox Chemical Stoneware

AEROX LIMITED

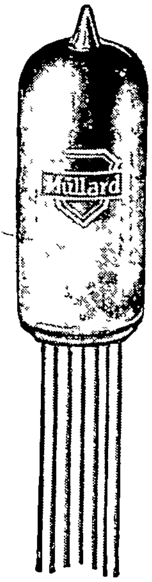
Filter, Aerator & Diffuser Engineers & Manufacturers

Head Office and Porous Ceramic Works Hillington Road Glasgow S W 2
Phone Halfway 2015 Grams Filters Glasgow
Southern Office and Filter Works Crompton Way Crawley Sussex
Phone Crawley 1277 Grams Aeromic Crawley

High Performance VOLTAGE STABILISERS and REFERENCE TUBES

Close tolerance burning voltages
Wide range of operating temperature
Good stability over life
Freedom from output voltage "jumps"
Long operating life

NOW ALSO AVAILABLE IN SPECIAL QUALITY RANGE



The high performance of Mullard stabilisers has been improved even further by the introduction of *Special Quality* types, which will operate satisfactorily under rigorous conditions of shock and vibration. These special versions of normal production types combine extra-rugged construction with what has proved to be an inherently reliable principle of design, and they will be available in addition to the normal range.

Samples selected from every production batch of *Special Quality* tubes are tested against Services' specifications to withstand impacts of 500g and vibration of 6g at 175 c/s.

All three of the *Special Quality* tubes can be supplied with either pin or flying lead bases. Your enquiries for further details of these and other stabilisers in the Mullard range are welcomed at the address below.

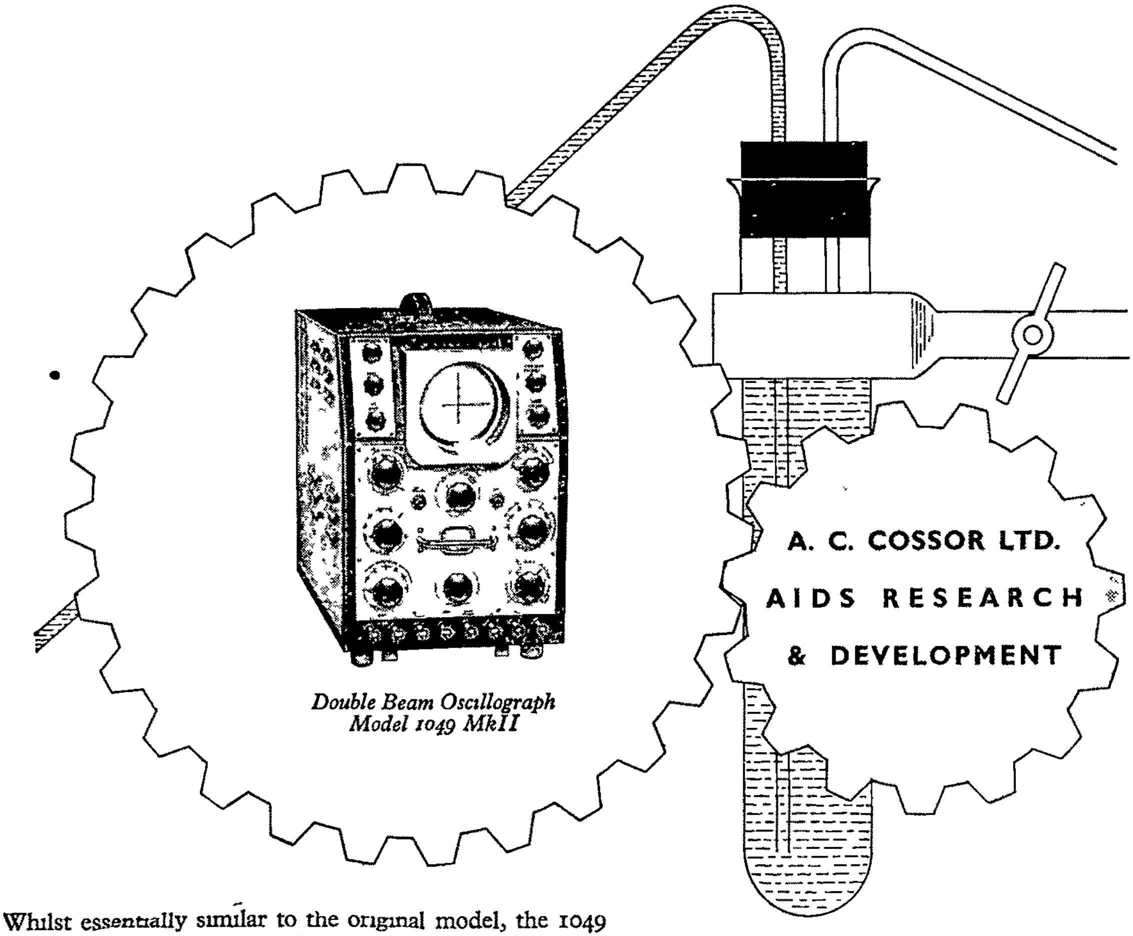
Special Quality Type No		Electrical Equivalent		Burning Voltage (V)	Current Range (mA)	Maximum Ignition Voltage (V)
Pin Base	Flying lead Base	Mullard	British Services			
M8098	M8142	85A2	CV449	85	1 to 10	115
M8206	M8207	90C1	—	90	1 to 40	115
M8163	M8208	150B2	CV2225	150	5 to 15	180

Mullard
SPECIAL QUALITY VALVES

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MVT 170



Double Beam Oscillograph
Model 1049 MkII

Whilst essentially similar to the original model, the 1049 Mk. II provides added reliability against high voltage breakdown by the use of a sealed, oil-filled E.H.T. power transformer. The instrument meets the requirements of Industry and the Research fields of Physics and Medicine by providing an oscillograph for the display and measurement of phenomena of zero or very low frequency and those where amplifier bandwidths of up to 100 Kc/s are required. The oscillograph incorporates the Cossor 4″ flat-screen Double Beam tube (type 89) operating at 2 Kv but provision is made for operation at 4 Kv when maximum spot brightness is required. The amplifier circuits are direct-coupled throughout and provide independent amplifying channels for the Y1 and Y2 Beams with a gain of 900 and 25 respectively from zero frequency to 100 Kc/s. Input signal voltages and frequency may be measured on either channel using the calibrated dials and special anti-parallax graticule. The direct-coupled Time Base is arranged to provide a repetitive or triggered scan with a time range of 1.5 seconds to 150 micro-seconds and can be synchronized from a pulse derived either from the internal wor circuits or from an external source. A continuously variable control adjusts the amplitud of the sync. or trigger signal and selects th polarity of the pulse from which synchronizatio is desired. "Z" modulation system is incorporated for time-marking purposes. Stabilization against mains variations up to 10% i provided for amplifiers and cathode ray tub supplies. Long period stability is reached withi 5-10 minutes of switching on. A pre-amplifie (Model 1434) and photographic recording equip ment is available for this oscillograph.

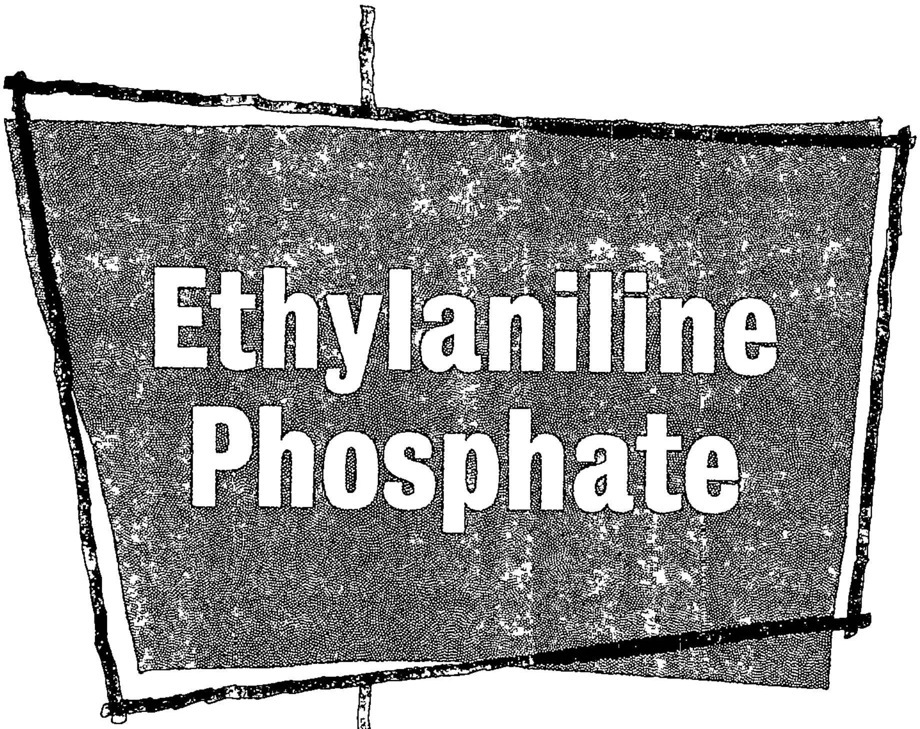
The Technical Advisory Staff of the Cossor Instrument Division is always at your service.

COSSOR ELECTRONIC INSTRUMENTS

Please address enquiries to

A. C. COSSOR LIMITED · INSTRUMENT DIVISION (Dept. 34) · HIGHBURY GROVE · LONDON, N.
Telephone · CANonbury 1234 (33 lines) *Telegrams* Cossor Norphone London *Cables:* Cossor Londo

C16



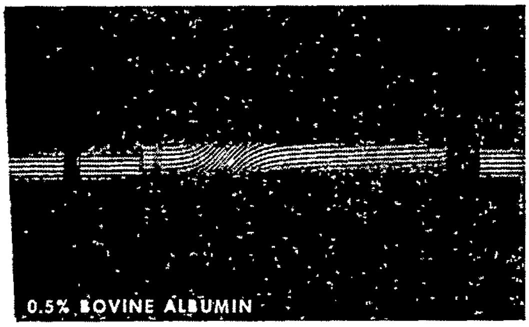
Ethylaniline Phosphate is one of a series of organic phosphates now being produced by Albright & Wilson Ltd. It is a white crystalline substance soluble in alcohol and having a composition corresponding to the formula $2(C_6H_5.\ N(C_2H_5)_2)\ 3H_3PO_4$.

It is used to prevent shellac varnish and French polish stored in tinned iron containers from attacking the iron and giving rise to a darkening of the varnish or polish. The addition of 0·5% by weight of ethylaniline phosphate forms a protective phosphate coating on the metal surface and prevents any reaction between the container and contents

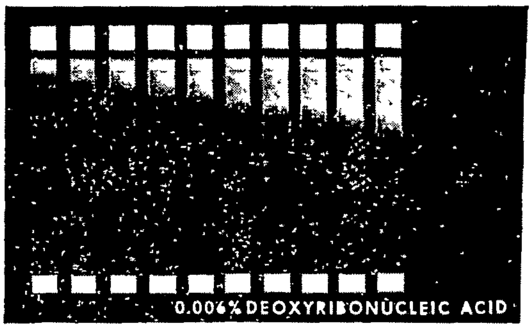
ALBRIGHT & WILSON

ORGANIC PHOSPHORUS
COMPOUNDS

ALBRIGHT & WILSON LTD 49 PARK LANE LONDON W1 · Tel GROsvenor 1311
TBW 452

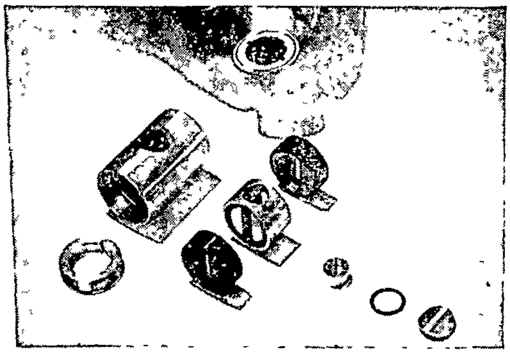


RAYLEIGH INTERFERENCE FRINGES provide high-sensitivity measurement of solute concentration at any level in analytical cell Used for determining molecular weights—both high and low—by the equilibrium method, as well as for measuring sedimentation velocity by the centrifugal transport of material past a given level in the cell

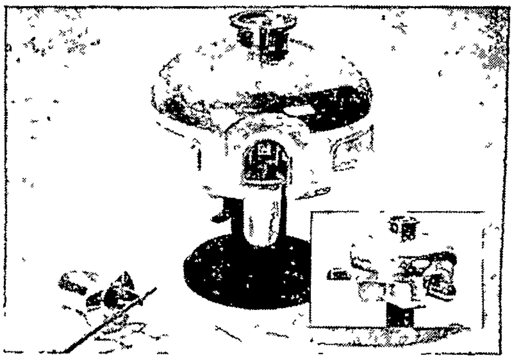


ULTRAVIOLET ABSORPTION method gives very high sensitivity with respect to concentration rather than concentration gradient, as in schlieren techniques Newly-designed optical system is particularly valuable for such materials as nucleoproteins and other ultraviolet-absorbing substances exhibiting diffuse or inhomogeneous boundaries

HOW new developments have increased the versatility of Analytical Ultracentrifugation



SYNTHETIC-BOUNDARY cell permits establishment of an immediately-measurable boundary by a layering technique This extends sedimentation-rate measurements from the previous practical lower molecular-weight limit of 10,000, downward to 500



40,000 rpm SWINGING BUCKET rotors make preparative operations most closely comparable with analytical, give most accurate estimation of sedimentation by sampling Boundaries sediment normally and undergo minimum reorientation Quartz inserts permit spectrography

Since 1947, when it was introduced, the Spinco Model E Analytical Ultracentrifuge has been constantly broadened in utility by new developments in equipment and technique.

Besides the specific items illustrated above, provisions have been made for (1) simultaneous analysis of two materials in the same rotor, (2) temperature measurement and continuous, automatic control of operating rotors to better than 0 1 degree C from zero to 100 degrees C, and many other specialized functions

Each of these developments has been engineered to permit its application to any Spinco Model E in existence Your inquiry is invited for further information on these or other developments which may provide solutions to your problems in physical research

Spinco

SPECIALIZED INSTRUMENTS CORPORATION

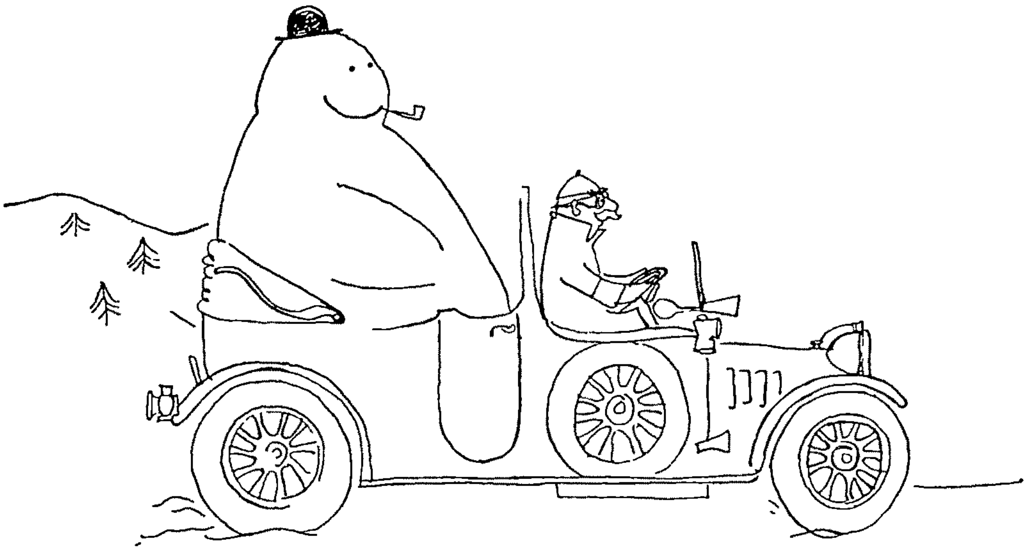
REPRESENTATIVES **BELMONT 6, CALIFORNIA**

Great Britain
HAWKSLEY & SONS, LTD
17 NEW CAVENDISH ST
LONDON W 1

Western Europe
ANALIS
14 RUE DEWEZ
NAMUR, BELGIUM

Scandinavian Countries
LKB-Produkter
Fabriksaktiebolag
Postaddress Box 12035
Stockholm 12, Sweden

Australia
H B SELBY & CO
254A GEORGE ST
SYDNEY, N S W , AUSTRALIA



Purer than the driven snow!

Ask T. B. Ford for the answer to any filtration problem, and a perfectly pure and lucid filtrate is yours. Ford's are experts in filtration. They make filtration media for every type of filter—and the standard of efficiency is unsurpassed.

From Ford's, you can obtain filtration media so efficient that they can be used to remove contaminating bacteria and moulds, thus sterilizing the liquids passed through them. This thorough filtration is achieved by the careful, precise admixture of asbestos fibres and cellulose, providing a mat that retains a high degree of porosity and permits a high rate of flow. Ford's Sterimats and Claraid not only filter but adsorb any micro-organisms that would spoil an otherwise stable, immaculate, crystal-clear filtrate.

Twenty years of continuous laboratory research and experiment have made T. B. Ford Ltd. *the* authority on every aspect of filtration media. And they make the best in the world.

This laboratory service is filtration NEWS!

Ford's provide a laboratory service, staffed by a team of experts, which is available to all manufacturers, free of charge. Some manufacturers, with their own fully-equipped laboratories, simply want Ford's to check and confirm their own research findings. Others call upon Ford's to solve some particular problem in their filtration process, whether directly concerned with the media itself or not. Whatever the problem, Ford's will gladly undertake the necessary laboratory research. Write to T. B. Ford Ltd., Laboratory Service, 101 High Holborn, London, W.C.1

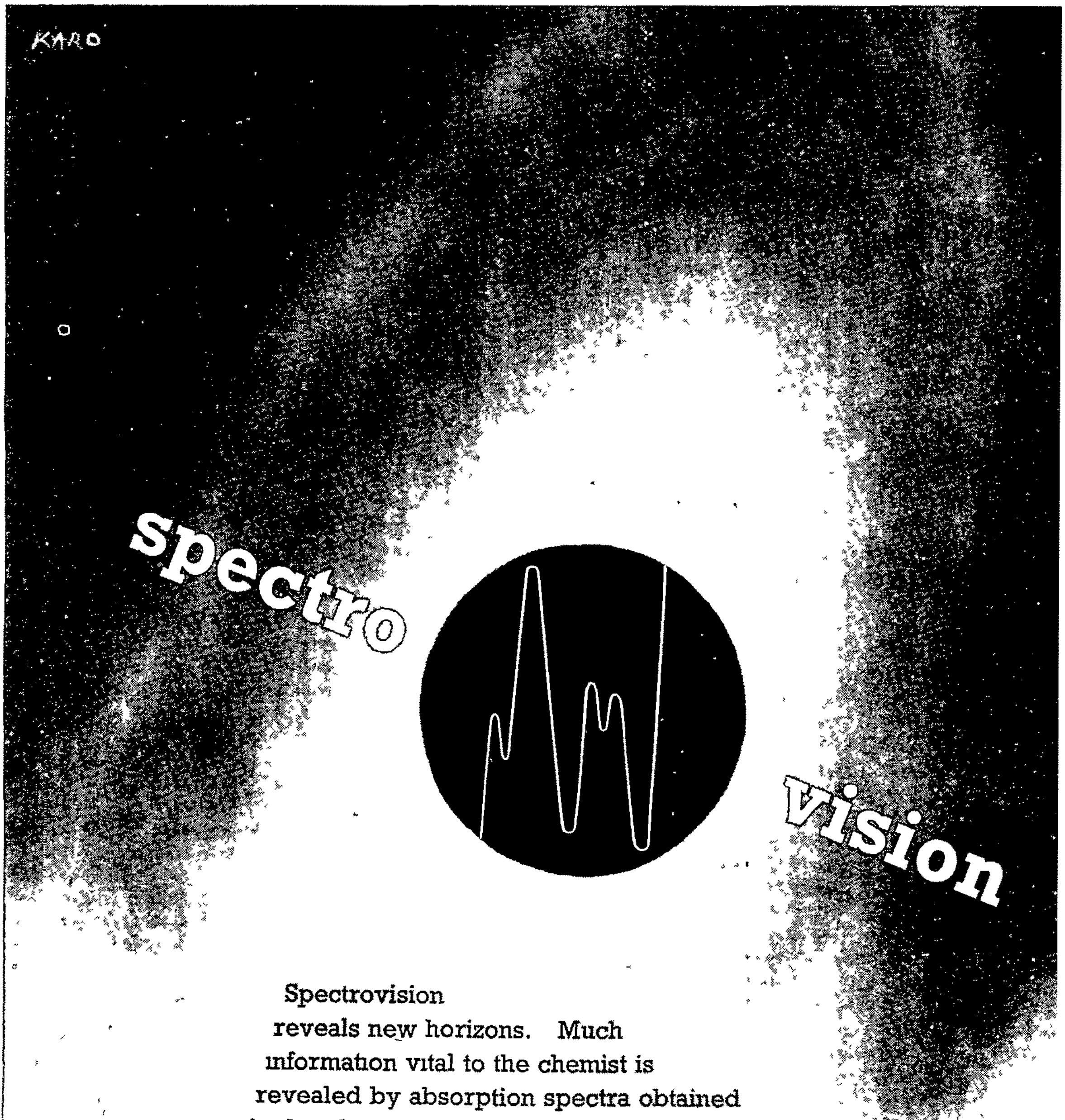
Famous chemical products are filtered by FORD'S

T. B. FORD Ltd

FORD 428 MILL

REGISTERED TRADE MARK

T. B. FORD LTD., TECHNICAL ADVISERS ON FILTRATION MEDIA AND MANUFACTURERS OF STERIMATS, CLARAID, FILTER PULP AND FILTER PAPER



Spectrovision reveals new horizons. Much information vital to the chemist is revealed by absorption spectra obtained in the ultraviolet, visible and infrared regions. The tool for this purpose is the spectrophotometer which provides analytical data easily and accurately, speeding research and production and preventing waste Unicam Instruments of Cambridge will gladly tell you how you may add the faculty of Spectrovision to your present resources.

UNICAM
SPECTROPHOTOMETERS

NATURE

No 4450 SATURDAY, FEBRUARY 12, 1955 Vol 175

CONTENTS

Page
Co-operation and Development in South-east Asia 269

Physiology and Animal Production By Prof J E Nichols 270
Quantitative Genetics of Populations By Dr G Pontecorvo 271
Biochemistry and Reproduction By Dr F Lundquist 272
An Anthology of Anthropology By Dr E Ashworth Underwood 273
Microwave Spectroscopy 273

Coal and Smokeless Fuels By Sir Charles Ellis, F R S 274
Powder Metallurgy By Dr I Jenkins 276
Education and Training of Radio Engineers By Prof. E Williams 279

Obituaries

Sir Shanti Bhatnagar, O B.E , F R S. By Sir Alfred Egerton, F R S 280
Dr. G F C Searle, F R S By Prof Frank Horton, F R S 282

News and Views 283

The Biological Council a Progress Report By Dr W P K Findlay 287
Medical Research Laboratory of Vojvodina, Novi Sad, Yugoslavia By Dr P Schwarz 288
The British Gelatine and Glue Research Association Research Panel Meeting By A G Ward 289
Statistics of Windfalls and Disasters By David G Kendall 290
Institute of High-speed Mechanics, Tôhoku University By S Weintroub 290
Sources of Germanium in Great Britain By R H A Crawley 291
Nitrifying Organisms in Glasshouse Soils By Dr R Klein 292
Position and Reactivity of the Histidine Residues in Cytochrome *c* By Dr E Margoliash 293

Letters to the Editors

The Sun's Magnetic Field and Corpuscular Emission —Dr Horace W Babcock and Harold D Babcock 296
Non-Linear Plasma Oscillations and Bursts of Solar Radio Emission —S F Smerd 297
Disintegration Scheme of Copper-62 and its Relation to Recent Mass Measurements —J M Reid and I F Wright 298
Thermal Diffusion Potentials and the Soret Effect —Dr J N Agar and W G Breck 298
Fission of Peptide Bonds by Lithium Borohydride —J C Crawhall and D F Elliott 299
Protein Synthesis in the Cell Nucleus —Prof Daniel Mazia and Dr David M Prescott 300
A New Reagent for the Histochemical and Chemical Detection of Calcium —S M McGee-Russell 301
An Intracellular Lipoidal Cycle and its Disruption by Neutral Red —Dennis Lacy 302
Lipid Nomenclature —H H Hutt 303
Flowing Chromatography on a Circular Paper Pack —Prof K V Giri and D B Parihar 304
Relative Contribution of Disparity and Convergence to Stereoscopic Vision —A A Rady 305
Functional Structure of the Retinal Fovea and Maxwell's Spot —Kosaku Isobe and Prof Koiti Motokawa 306
Grouped Variations in the Occurrence of New Protein Components in Normal Human Serum —Dr O Smithies 307
Long-Term Transplants of Infantile Rat Pituitaries cultivated *in vitro* and grafted in the Anterior Eye Chamber of Young Cats —Petar N Martinovitch and Dushanka V Radivojevitch 308
Paratyphoid-A Phage Typing —Prof D D Banker 309
Nature of the Pigment of *Aplysia depilans* —Prof A Christomanos 310
Peculiar Stratified Shape of Typhoon Waves —Fr E Gherzi, S *J* 310

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO , LTD , ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd , Crown House, 143–147 Regent Street, London, W I
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

SIR JOHN RUSSELL
F.R S

World Population and World Food Supplies

"A monumental work of reference and only one so erudite, experienced, and energetic as he could compile it He surveys not merely what has been achieved but what can still be done to raise food production in the major exporting and importing countries "—MANCHESTER GUARDIAN

"This book, with its wealth of information on the present position and possibility of development of agriculture in the different countries of the world, is a valuable addition to the growing literature on the question of whether the population will grow to a size that the earth will not be able to support "—NATURE

Illustrated 50s.

GEORGE ALLEN & UNWIN LTD
40 Museum Street, London, W C 1

Analysis of Drugs and Chemicals

by N. EVERS & W. SMITH

Dr N Evers is editor of *Analytical Abstracts*
Mr W Smith is Chief Analyst of Messrs Allen & Hanburys Ltd

This entirely new book contains information you will find nowhere else on the following subjects physical and volumetric methods of analysis, general methods for determining specific constituents, inorganic and organic chemicals, natural compounds and their derivatives, fixed oils, fats, waxes, and soaps, volatile oils and crude drugs, miscellaneous pharmaceutical materials and galenicals Of particular interest is a chapter on the use of statistics in chemical analysis The authors' close association with the B P and B P C has enabled them to write an indispensable supplement to these works
Medium Octavo 540 pages 60 shillings net

CHARLES GRIFFIN & CO. LTD
42, DRURY LANE, LONDON, W C.2

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?
Suppliers to all Leading Universities, Public Libraries and Institutions of the World
Catalogues issued

★

SELLING?
Specialists in Scientific, Technical Books and Publications of all Learned Societies

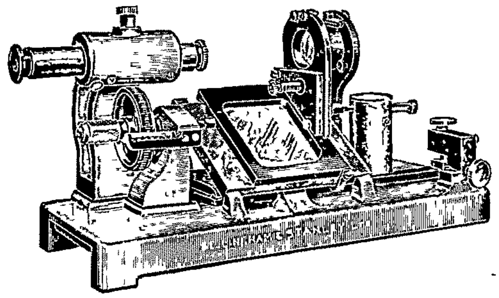
★

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephone Wel. 7948, *Amb* 5991

PRECISION BS INSTRUMENTS

Fabry-Perot Interferometer



Although of very simple design, this instrument is suitable for much of the work usually carried out by more elaborate and costly apparatus, and reads directly to 1/250 mm
Price Complete £150 0s.
Case, consisting of base on which instrument is attached, and box cover, extra £9 10s.

Bellingham & Stanley Ltd
DEPT N, 71 HORNSEY RISE, LONDON, N I
PHONE ARCHWAY 2270

CO-OPERATION AND DEVELOPMENT IN SOUTH-EAST ASIA

IN the debate on December 3 in the House of Commons dealing with Colonial development and related matters, there were some interesting references to the progress of the Colombo Plan for the economic advancement of South-East Asian countries The information given on that occasion is amplified by the report for 1953–54 by the Council for Technical Co-operation in South and South-East Asia* and by the third annual report of the Consultative Committee on Economic Development in South and South-East Asia, which has since been published† The former shows clearly how technical co-operation has widened its scope Not only are all countries of the area participants in the scheme and, except Thailand, the Philippines and Laos, full members of the Council, but also technical co-operation has become more closely related to capital aid and to actual needs and priorities established by the Asian countries in their national development plans There is now a tendency towards operations involving all three forms of technical co-operation—experts, trainees and equipment—along with capital aid, and disconnected operations are replaced by co-ordinated and continuous operations with one project serving as a link in the chain of planned development.

With these two trends has been an approach to a better balance between the training of the countries' nationals at home and abroad The flow of trainees abroad has not diminished, but it is now apt to be concentrated on higher training Mutual technical co-operation among the countries of the area has also developed, and the report cites examples of the exchange of experts and the offer of training facilities in institutes or on development projects to countries about to embark on similar projects The expansion of technical assistance has also made more urgent the need for co-operation among the numerous agencies working in this field

Up to June 30, 1954, about £2 million had been expended under the Scheme against appropriations of £8 million, and a further £2 million was committed This compares with more than £1,000 million already spent on economic development programmes, but the report points out that it is not easy to assess the impact of technical assistance Such co-operation is usually applied at strategic points of the economy, and often the expert is a catalyst of the whole economy Nevertheless, there seems to be little doubt as to the real contribution which most of the individual technical aid projects have made to the national economic development plans, though the report fully recognizes that there is always room for improvement.

Among the current difficulties on which some stress is laid are the determination of priorities and the timing of projects. There are also difficulties in the selection of trainees and of equipment, and in finding the right expert for the job Posts of professors at universities and technical institutes are hard to fill, for example, and it is difficult to recruit some types of engineers and technicians There is an increasing demand for experts to undertake executive responsibilities as well as offer technical advice. It is suggested that more use could be made of firms of consultants, and that better use could be made of the equipment provided if it could be associated with the work of experts in the field, or of trained men returning from studies abroad

These difficulties are fully appreciated in the report on the Colombo Plan as a whole which the Consultative Committee has issued since its meeting at Ottawa in October, at which Thailand, Japan and the Philippines were admitted as full members of the Plan. The chapter of that report which deals with technical assistance does not indeed go into such detail, but it sets its progress against the broad background of the other technical co-operation schemes operating in the area, under which nearly 5,000 places in all have been provided for technical training and some 2,500 experts and technicians have been sent to put their skill at the service of the countries concerned Even so, the progress of the Technical Assistance Programme, which manifestly is increasingly appreciated by the Asian members, stands out, with the increase of 27 per cent in total development expenditures throughout the area—a figure expected to increase by 31 per cent in the current year—as perhaps the two most satisfactory features of the report

The full impact of the development programme, like that of the Technical Assistance Programme, will not be felt for some time, in view of the long-term character of many of the projects Indeed, the value of the technical assistance programme cannot be measured adequately either in monetary or statistical terms, but it has clearly played a vital part in the economic progress recorded in this report, and the Technical Co-operation Bureau which has been established at Colombo during the past year, in accordance with a recommendation at the New Delhi meeting in October 1953, to establish direct channels of correspondence with information units of member countries, to collate and distribute information and to constitute a central pool of information in the Colombo Plan, should undoubtedly facilitate that process Meanwhile, without under-rating the magnitude of what still remains to be done, it can be said that the decision to embark on far-reaching and comprehensive programmes of economic development was both courageous and right

Co-operation between the member countries is now taken for granted, and while the financial problems of the Colombo Plan countries, relative to the needs of development, are most serious and the gap between estimated costs of development programmes and foreseeable available financial resources is widening rather than narrowing, the growing extent to which resources have been mobilized for development outside conventional financial mechanisms is encouraging. The Asian countries are aware that the main burden must be borne on their own resources, though external aid can smooth and accelerate progress towards a higher standard of living. They are aware, too, of the difficulties that attend planning within a framework of democracy, and for some of them the problems of development are rendered infinitely more complex by political and economic instability and the scarcity of trained administrators and technicians.

---

* The Colombo Plan, Technical Co-operation Scheme Colombo. July 1954 (London H M S O, 1954) 1s net

† The Colombo Plan Ottawa, October 1954 Cmd 9336 (London H M S O, 1954) 4s net

Despite these problems, the future of the Plan appears promising now that its members are conscious of a great and growing partnership, animated by a common purpose and increasing awareness of each other's problems and aspirations. That future is all the more promising in view of the prospects of American economic aid to this area. The Colombo Plan has, it should be recognized, gone some way to create the conditions in which such additional money can be effectively used. The primary need for technical aid is being met, and some steps have been taken to hammer out a well-balanced and intelligently applied economic programme which can counteract inflation. Evidence of maturity is growing; but this is a slow process and care will be required if the new American proposals are not to tempt the backward countries to take on huge programmes of development with their own overtaxed—and often corrupt and inefficient—administrations.

Perhaps even more important, no new offer or programme should promise conditions which will disturb the understanding and partnership which have already been established under the Colombo Plan. Neither ideology nor propaganda has anything to contribute towards the solution of the acute problems of economic development in South and South-East Asia, and either could easily hinder progress. That needs to be remembered as much by the critics of the British Government's proposals for Colonial development and welfare as by the Administration in Washington, where the future size and scope of American economic and technical aid to Asia is at present being debated.

Last November, Mr. Harold Stassen, director of the Foreign Operations Administration, suggested that, while Western Europe is no longer in need of American economic aid, the time is ripe for a massive effort to aid the economic development of the free nations of Asia. He had already denied that his Government, which attended the Ottawa meeting as a full member for the first time, would use the Colombo Plan as its main instrument for channelling economic aid into Asia. The Technical Aid (Point Four) Scheme, bilateral military and defence support agreements and the World Bank will continue to be the main agencies for American aid; and, while this new American initiative should be welcomed by all the Colombo Plan countries, much more thought is required as to the way in which the American contribution can best be given. If, for example, the financial contribution is on the scale that materia needs alone would require, the balance and th unique relationships of the Colombo Plan could easil be upset and distrust and resistance aroused b vested interests.

While any such generous gesture from the Unite States deserves to be warmly welcomed, and althoug the financial needs of the under-developed countrie are still great and scarcely diminished as yet by th Colombo Plan and other agencies, much joint stud is yet required before the manner in which America resources can best be made available can be determined. It is in this context that Britain's plans fo Colonial welfare and development need to be considered. Her contribution to the Colombo Plan an to the Technical Assistance Programme of th United Nations is not one of which she needs to b ashamed, and it is only a small part of the contributio made from her limited resources to world welfar. Apart altogether, however, from such questions a the tempo of development, the order of prioritie and the magnitude of the resources we can afford t allocate for overseas development, Britain has bot a great responsibility and a unique opportunity fo leadership in evolving the appropriate forms o co-operation and the safeguards against any attempt to use such schemes for ideological purposes. If tha opportunity is to be used, however, and tha responsibility faithfully discharged, Colonial welfar and development cannot continue to be made th plaything of party politics. Both major politica parties must bring to the task the magnanimity, th vision and the statesmanship without which n financial generosity is likely to achieve its purpos of securing a fuller economic development of th under-developed countries and a clearer understanding and closer co-operation between them an the Western world.

PHYSIOLOGY AND ANIMAL PRODUCTION

Progress in the Physiology of Farm Animals

Edited by Dr. John Hammond. Volume 1. Pp vii+392. (London: Butterworths Scientific Publications, 1954.) 45s. net.

IN recent years the lack of either an adequate textbook or a comprehensive reference book recordin the marked advances in the scientific study of anima production has been seriously felt by all whos interests lie in this field. On one hand, as Dr. John Hammond rightly points out in his preface t this volume, "present day medical and veterinar textbooks cover too narrow a field"; on the other scientific contributions range widely and tend eac to be highly specialized; they are reported in suc a multiplicity of publications that even researc workers find increasing difficulty in familiarizin themselves with progress in their own sector an much more in the field as a whole. But, quite apar from the needs of advanced students, researc workers and teachers, there has developed a marke awareness on the parts of farmers and stockme engaged in animal husbandry that successful practic must depend upon a sound foundation of applied physiological knowledge

No one person can be said to have changed the attitude of the practitioner to his work and problems more than Dr Hammond, whose own research and influence have contributed so greatly to the development of scientific animal production. It is therefore of considerable interest to notice his appreciation of the general needs, as marked by the topics into which he has segregated the general scope of recent scientific advances, and by the collaborators he has chosen to review them in the series of volumes of which this is the first to appear under his editorship

Clearly, progress in physiological studies has not been made on an even front, so that some variation in content, authority and scientific and practical significance of the different sections is only to be expected, particularly when the contributors have, wisely, been allowed a good deal of freedom of approach to their own particular interests Even so, it must be pointed out at once that this volume suffers from inconsistent proof-reading and inadequacies of expression as between various sections, together with some overlapping of matter, these minor blemishes can easily be overcome in future editions and in the further volumes of the series

Two main segments of the general field are covered here nutrition and metabolism, and environment Many considerations must obviously affect the sequence of contributions in such a compilation, but the present reviewer's preference would have been to give the latter some priority of appearance, not because of the nature of the contributions or their significance, but simply because the complex of ecological factors affecting animal production is that which the animal husbandman, and the scientist, are least able to control, yet largely decides the broad patterns of production as found in practice

In reviewing ruminant nutrition, K. L. Blaxter properly orients the discussion by starting with aspects of rumen development with age, and then proceeding to a useful, critical and thoroughly up-to-date treatment of the parts played by the rumen flora in carbohydrate and protein metabolism Following this, R Braude presents an equally thoroughly documented and comprehensive review on the nutritional requirements of the pig, which may well rank as one of the outstanding contributions to the literature of farm animal physiology for many years to come, in any event, it is valuable at the present time, and has an additional merit for advanced students in frankly indicating the gaps and weaknesses of current information in relation to practical conditions of pig management

In marked contrast to these, W Bolton has relied very largely on already available reviews of the field of poultry nutrition, and has sought, instead of bringing their matter up to date, to make a formal treatment of his topic possibly more appropriate to a text-book concerned particularly with biochemical aspects. Only eleven authors are directly quoted What, however, is taken to be the main conception of the whole volume is regained in D. P. Cuthbertson's section, which provides a most useful statement of the trace element situation in its broadest relations with animal production, particular care has been taken in the discussion of those complex cases where deficiency or excess of more than one element is involved.

About half the present volume is devoted to environmental considerations, to which N. C Wright's comprehensive examination of work on the ecology of domesticated animals forms a most appropriate introduction Breadth and precision of treatment are here most successfully attuned to yield another notable contribution to the literature, enhanced by the author's clarity of expression and the fact that this section is conspicuously free from proof errors Its value is such that it prompts a criticism—that from the wealth of his familiarity with this field the author might well have thrown out ideas regarding the techniques of study and on other ecological factors that await analysis.

J D. Findlay and W. K Beakley, active participators in research on the environmental physiology of farm animals, give a critical review of experimental work, in which they do not hesitate to suggest its practical implications or to point out the needs for further investigations, as, for example, on the neuro-endocrine systems. Their main concern is with the thermal environment and heat regulation in mammals, but J. C D Hutchinson in his review of heat regulation in birds has found it necessary to refer to man and to repeat some of their material in attempting to give a reasonable orientation to his, especially since he enlarges his task to include discussion of the role of birds in food production, particularly in the now under-developed agricultural regions.

The final section is contributed by N T M. Yeates, who has brought together old and new information on the influence of daylight changes on reproductive and other physiological processes, almost at times with special pleading to establish its fundamental significance in practical animal production

Dr. Hammond earns not only the congratulations but also the grateful thanks of all those whose needs he has so well sounded, for placing in their hands what must be regarded as an indispensable reference for this and a considerable future time.

J. E. Nichols

QUANTITATIVE GENETICS OF POPULATIONS

Symposium on Genetics of Population Structure held at Istituto di Genetica, Universitá di Pavia, Italy, August 20–23, 1953

Edited by Adriano A Buzzati-Traverso (Union Internationale des Sciences Biologiques Série B—No 15) Pp 141. (Naples Secrétariat général de l'U I S B, 1954. Distributed by Libreria Internazionale Garzanti, Palazzo Universitario, Pavia, Italy) 2 30 dollars

The twenty participants to this symposium included all the foremost authorities on the subject, with the exception of Sewall Wright The aim was to ensure an exchange of views on those aspects of quantitative inheritance which are most relevant to the genetics of populations For this reason there were few papers, most of the time was available for discussions Unfortunately, these have not been published Besides six papers, the Proceedings of the Symposium contain short comments by Dobzhansky, Lerner and Epling, the conclusions by Buzzati-Traverso and the scholarly but delightful address of thanks by Haldane These glimpses are certainly enough to whet the appetite of the reader and to make him the more regretful that the discussions have not been published in full

As to the six papers, Clayton, Morris and Robertson gave a summary of a long-term programme, still in progress, of selection for high and low numbers of abdominal bristles in *Drosophila* (It is a mystery why these authors, and most other geneticists, persist in calling the bristles 'chetae', instead of 'setae') One of the interesting results after five generations of selection is the great variation between replicates of the same selection experiment, as if initial sampling accidents were quite important.

A paper by Falconer dealt with the asymmetrical response in mice to selection for high and low weight and high and low milk yield In both experiments there was a more rapid response downwards than upwards The author suggests that this asymmetrical response would be expected in cases in which either or both "unequal initial gene frequencies" and "directional dominance" occur These two terms are defined precisely

Scossiroli reported on the results of selection for bristle number in *Drosophila* populations after heavy X-ray irradiations The starting populations used had been selected already for twenty-seven generations prior to irradiation, and further selection was no longer capable of producing further inheritable change After X-irradiation there occurred a new spectacular response to selection in the 'high' direction but not in the 'low' one It seems to the reviewer that the main interest of this work lies precisely in this difference It could be that X-ray-induced inheritable variation is mainly in the direction opposite to that for which natural selection had to work harder—a point well worth investigating at the threshold of the atomic age The canalization of developmental systems may be such that any one of them is more liable to upset one way than the other The genes picked up by natural selection in the past history of the species would buffer asymmetrically either there would be more acting against the direction of more likely disruption, or they would be more effective Destructive mutations are therefore more likely to act one way Artificial selection after irradiation will be more effective than before irradiation one way, but less effective the opposite way Contrary to the first impression which might be gathered, this experiment suggests that irradiation is likely to increase the rate of change, but only in the direction opposite to that of natural selection

Wallace reported on 'coadaptation' of the various linear arrangements of the third chromosome in wild populations of *Drosophila pseudoobscura* This paper contains such a wealth of valuable information that it is not possible to summarize it here It certainly convinced the reviewer that there is a tendency for pairs of chromosome sequences within one population to be reciprocally adapted in the sense of conferring increased fitness to the structural heterozygotes

A paper by Clausen considered the dynamic balance between variations or fluctuations in the environment and potential or expressed variation in populations One by Harland Lewis reported on chromosomal variation in the *Clarkia* genus He concluded in favour of causal relations between additional chromosomes and colonization of new habitats.

The summing up by Buzzati-Traverso, and the comments by Dobzhansky and Lerner, clearly showed how far the classic theoretical framework of population genetics has led, and how necessary it is that the change in outlook already in progress should go on and be put to test This change in outlook is essentially a shift of emphasis from the single gene to the integrated systems of chromosomes, the genotypes of the individuals and the whole gene pool of populations For this change in outlook the theoretical tools—statistical, ecological and developmental—are still lagging behind G PONTECORVO

BIOCHEMISTRY AND REPRODUCTION

The Biochemistry of Semen

By Dr T Mann. (Methuen's Monographs on Biochemical Subjects) Pp. xiv + 240 + 7 plates (London Methuen and Co., Ltd , New York John Wiley and Sons, Inc , 1954) 16*s* net

THE increasing use of artificial insemination in animal husbandry, and even to some degree in human medicine, is based to a considerable extent on knowledge of the metabolism of spermatozoa, their nutritional requirements and the physical conditions necessary to secure prolonged life outside the organism This body of knowledge has hitherto been widely scattered in publications, many of which are not readily accessible It is therefore with great satisfaction that one welcomes a monograph on this rapidly expanding subject, written by a man of science who, together with a number of co-workers, has made outstanding contributions to our knowledge of the composition and metabolism of semen Dr T Mann's book is the first comprehensive exposition of the biochemical facts and problems relating to reproduction in mammals as well as lower forms (including even an occasional paragraph about plants)

The biochemistry of semen may appear at first glance to be a very special field without much interest outside the rather narrow group of specialists actually engaged in research on seminal biochemistry , but in fact this book should appeal to a much wider public, including not only veterinary officers interested in artificial insemination and clinicians studying problems of human fertility, but also the general biochemist who through reading it will realize that the biochemical mechanisms operating in the elaboration of the numerous components of seminal fluid present many absorbing problems The general biochemist may also find that spermatozoa offer many advantages as a material for the study of intermediary metabolism in the intact cell, because they are easily obtained uncontaminated by other cell types, and their physiological activity manifests itself through easily observable movement

The difficulties which are inevitable when an attempt is made to review so heterogeneous a field have been solved in a very satisfactory way The introductory chapter gives a kind of cross-section of the book, surveying in a clear and sufficient manner the anatomy of spermatozoa and of the accessory sex glands, and gives a description in chemical and physiological terms of the various secretions contributing to the seminal fluid In the following two chapters is found a thorough and critical discussion of such topics as the physical and chemical criteria used for assessing the quality of semen, the freezing of sperm, spermicidal agents and the use of various diluents for spermatozoa

The second half of the book is devoted to a more detailed treatment of the impressive array of specific substances found in spermatozoa and seminal plasma Among these substances may be mentioned fructose, which in most species so far studied constitutes the main nutrient for the sperm cells, inositol and citrate, found in large amounts in some animals, ergothioneine, various choline compounds and a number of enzymes. This scholarly discussion of many fundamental biological problems should prove of considerable interest also to biochemists and physiologists working in other fields.

The historical background for the development of seminal biochemistry is by no means neglected; some readers may even hold that too much space is devoted to historical matters. In my opinion, however, this historical note is important in a book which will undoubtedly become the standard text in the field, and certainly contributes greatly to make pleasant reading. The illustrations are on the whole very well chosen, but a number of structural formulæ of simple substances (one of which contains two misprints) might well be omitted. The list of about one thousand references, though not complete, will be found very useful, and so will the subject index. Author, editors and publishers are to be congratulated upon the production of this excellent monograph.

F. Lundquist

AN ANTHOLOGY OF ANTHROPOLOGY

Primitive Heritage

An Anthropological Anthology. Edited, with an Introduction, by Margaret Mead and Nicolas Calas. Pp xxx+592. (London: Victor Gollancz, Ltd., 1954.) 21*s*. net.

In a brief introduction to this book, Margaret Mead refers to the change in the type of anthropological literature which has developed in the past half-century. The armchair school of collectors of tales and legends was succeeded by the comparative school, which has become more and more dependent for its material on first-hand accounts of the life of individual tribes. In the text itself there is an essay by Ruth Benedict, published in 1932, in which the same attitude is taken. The reader who picks up this book for the first time might therefore expect a marked bias towards writings emanating from the psychological or psychoanalytical school of anthropologists. Any such fears may be discounted. The collaboration between the anthropologist and Nicolas Calas, the distinguished art critic, has produced an extraordinarily interesting anthology which will serve its purpose—to leave the reader often unsatisfied and in the mood to ask for more.

The fairness of the selection can readily be seen by a glance at the contents. The work contains one hundred and eleven extracts, and of these only about seventy date from the present century. The beginnings of the anecdotal school are represented by Herodotus, Tacitus and Strabo. The various parts of the work deal with such fundamental happenings or activities as childbirth, puberty, marriage, war, sport, death and immortality. Even those who have read much of the material in its original form will find renewed pleasure in reading straight through the book, as the reviewer has done. The extracts are very well chosen. There are some surprising omissions; but the compilers would no doubt justify them. Frazer and Westermarck find no place in the book, and it may be suggested that Tylor has just succeeded in gaining a place. Malinowski is well represented, as also are Sapir, Fortune and Ratcliffe-Brown. Hermann Melville gets in twice. The modern reporter of an international football match might read with profit Catlin's description of the ball game among the Choktaw, written more than a century ago. From the literary aspect one of the finest extracts in the book is written not by a professional writer or by an anthropologist, but by an artist—Maya Deren's passage from "Divine Horsemen".

In addition to its extensive use as a bedside-book—which is quite probable—this anthology may well be recommended to the student of anthropology as a rapid introduction to the great literature of the subject. In its next edition the compilers should certainly provide it with an index.

E. Ashworth Underwood

MICROWAVE SPECTROSCOPY

Microwave Spectroscopy

By Prof. Walter Gordy, Prof. William V. Smith and Prof. Ralph F. Trambarulo. (Structure of Matter Series.) Pp. xii+446. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 64*s*. net.

Microwave spectroscopy is a comparatively new branch of physics which has arisen out of the development of radar techniques during the Second World War. Already, however, significant contributions have been made to the fields of molecular and solid-state physics. This book, by Profs. W. Gordy, W. V. Smith and R. F. Trambarulo, attempts to survey and to summarize the information which has so recently been accumulated. Thus, it cannot be regarded as a text-book, although many research students will find it a useful and concise introduction to the techniques and results of this branch of spectroscopy. The major part of the book is devoted to topics concerned with the spectroscopy of gases; and although this is perhaps not unexpected in view of the contributions to this field from Prof. Gordy, nevertheless it does present rather a biased account when, of the three hundred and fifty pages available, only fifty are allocated to the discussion of the microwave investigations of the solid state.

After an introductory chapter on the techniques and design of microwave spectroscopes, there are three chapters summarizing the measurements on gases, one chapter on the microwave spectra of solids and liquids, and four later chapters devoted to nuclear properties, more detailed discussions of molecular structure and possible applications of the microwave experiments in other fields. The book is well written, admirably presented, and there seem to be very few printing errors. There are a large number of helpful diagrams and a valuable collection of references. The appendix contains an impressive amount of data in tabular form.

The book will undoubtedly appeal to the research worker wishing to refer to an up-to-date review of a rapidly expanding branch of physics. A book of this nature, however, suffers from a serious liability, since, in order to maintain its appeal, new editions must be available as the subject advances. In Britain the published price is 64*s*., and this is scarcely a price which can commend the book to scientific workers anticipating a later edition; many students may decide that the expense of the present edition makes ownership of the book a considerable luxury.

COAL AND SMOKELESS FUELS*

By SIR CHARLES ELLIS, F R S.

THE term 'solid smokeless fuel', as applied to domestic consumption in Britain, embraces the requirements of four classes of appliance (*a*) boilers and closed stoves, (*b*) openable stoves, (*c*) modern gas-ignition open fires, and (*d*) ordinary open fires

For boilers and closed stoves, anthracite and hard coke from coke ovens are excellent fuels, and 'Phurnacite', a manufactured fuel, is prepared specifically for this use All these fuels can also be used on openable stoves if these are carefully regulated A more reactive coke, such as gas coke, however, is really more suitable, and this type of fuel can also be used in modern open fires with their deep beds. These fires are, of course, even better served by the highly reactive specially carbonized fuels, such as 'Coalite' or 'Rexco', which can indeed be burnt quite satisfactorily on the ordinary open fire

Any new type of smokeless fuel can conveniently be described in terms of this classification by stating for which appliances it is eminently or reasonably suitable

It will be obvious that boilers and openable stoves are already fairly well catered for, and it is the provision of smokeless fuel for the open fire that presents the really difficult problem, for two reasons first, there are a great number of ordinary open fires, and secondly, any smokeless fuel that is to replace coal must be as reactive, that is, as free-burning, as coal

Coke, either hard coke or gas coke, will play an important part in any programme for the provision of smokeless fuel Unfortunately, only some of the coals found in Britain are coking coals, for example, it is impossible to make lump fuel directly in this way from powdered dry steam coal First of all it has to be mixed with pitch, and the resultant sticky mass pressed into the form of briquettes These briquettes have little strength, and would be very smoky if they were burnt because of the pitch they contain To give them the requisite strength, and also to get rid of the pitch, they are carbonized in a heated oven These are the essentials of the 'Phurnacite' process for making use of this finely divided coal

It must be emphasized that among the manufactured smokeless fuels already on the market, 'Coalite', gas coke, and oven coke are all made from carbonization coals, that is, coals which when heated to drive off the volatile matter become plastic and form a coherent coke If, then, the supply of smokeless fuels for the domestic market is to be increased, the question immediately arises whether this should be by processing more and more carbonization coals From the purely technical point of view, such a policy could be implemented straight away by putting up more plants along existing lines, but the vital factor in determining the National Coal Board's research policy has been an appreciation of the long-term supply position of carbonization coals

In the year 1952 the total production of coals of the types customarily regarded as suitable for carbonization was 97 million tons, while the actual consumption of coal by the coke and gas industries was 53 million tons At first sight, therefore, it would appear that there would be no difficulty at all in meeting the demands of these industries for coal In fact, however, the comparison ignores at least two important considerations First of all, a large tonnage of coking and gas coal (36 million tons in 1952) was too high in ash content or in sulphur content to meet the rather exacting specifications of the carbonizing industries From the balance of coal that is suitable in quality must now be subtracted the large coal, the total production of which is barely sufficient to satisfy demand (chiefly from the railways and the domestic coal market) The result of all this is that, far from there being a surplus of carbonization coal of these types, there is actually a deficit, which amounted in 1952 to 8 million tons This deficit is made good by the distribution to the gas industry of coal that in former days would have been regarded as too low in rank to be suitable for gas manufacture because the make of good coke was unsatisfactory. The tonnage of lower-rank coal taken by the gas industry has been increasing steadily for many years

Difficult as the position now is, it will not become any easier, because, speaking generally, British output in future will contain more of the lower-rank coals, which are easier to get than many of the higher-rank carbonization coals The coal requirements of the carbonizing industries are, on the other hand, expanding every year, both in terms of actual tonnage and in proportion to the total consumption of coal This is shown quite simply by the comparative figures for 1939 and 1952 in the former year the tonnage of coal supplied to the coke and gas industries was slightly more than 39 million tons, or 21 4 per cent of the total home consumption, whereas in 1952 it had risen to 53 million tons, or 26 per cent of the total

The realities of the situation make it imperative that any extension in the production of smokeless fuels should not make the supply position more difficult by utilizing high-rank carbonizing coals, new developments should depend on the comparatively low-rank general purpose coals

This was the situation that led the National Coal Board to decide that it must have some process by which it could manufacture smokeless domestic fuels from coals which would always be in ample supply, any new process must, moreover, use as its starting material fines or powdered coal, and not large coal or sized coal for which, generally speaking, demand is already in excess of supply

The two things to be done are, first, to agglomerate small or powdered coal into sizes and shapes chosen to suit their subsequent use, and secondly, to make this agglomeration smokeless

One further point must be made in order to explain the attitude of the National Coal Board to the problem The Board intends to develop a range of smokeless fuels that will be specialized to their individual purposes and will be premium fuels Though the urgency of the situation is clear, it would be wrong to be led into panic measures to deal with it To supply the necessary quantity of smokeless

---

* Substance of a Friday Evening Discourse at the Royal Institution on December 10

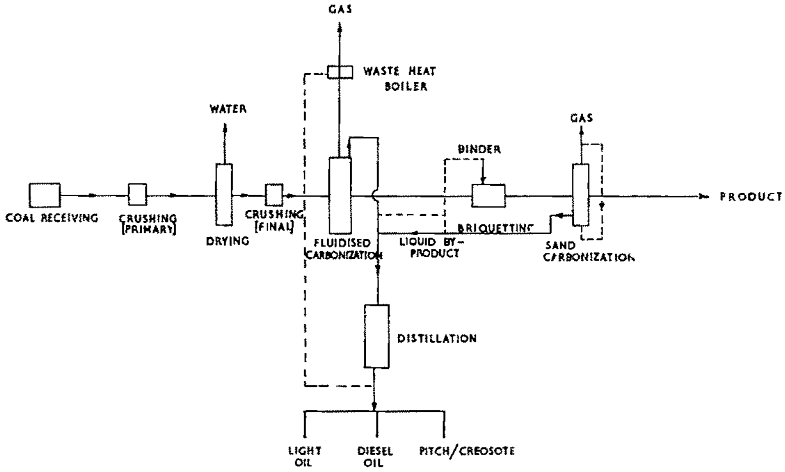


Fig 1 General flow diagram of combined process of fluidized devolatilization, briquetting and carbonization

fuel in one way or another may possibly involve the country in spending more than £200 million in building plants that may have a life of forty years To spend all this money on plant to produce smokeless fuel that is perhaps just good enough, but which no one really likes, would be ruinous The aim must be to build for the future and to develop new processes that will represent a real technological advance, based on the acquisition of new knowledge

The Board's Research Establishment at Stoke Orchard has for the past two years been focusing all its efforts on this problem, and from the beginning one thing was clear if the fuel was to be smokeless, it meant that a large amount of volatile matter had to be extracted, but the economic success of the operation would depend very largely on the extraction of that volatile matter in a useful and saleable form A series of operations on the coal, in contrast to the simple single process of the coke oven, was also envisaged, but if this were to be economically feasible, it would be essential to use the efficient methods of modern chemical engineering For these reasons, almost from the beginning it was decided to treat the coal in a fluidized state

The fluidizing process is now well known and is common practice in many industries If air or some other gas is driven upwards through a column of fine granular material such as sand or coal-dust, it is possible so to adjust the flow that the individual particles are practically airborne, and the mass as a whole has the mobility normally associated with a fluid The material has an average density corresponding to the degree of aeration, and objects will float or sink in it just as if it were a true fluid. If either hot inert gas or superheated steam is used as the fluidizing medium, then not only can the coal be moved from vessel to vessel like a fluid, but also it can be heated at the same time

Probably the most important advantage of this new approach is that it provides a better way of extracting volatile matter. The hot stream of fluidized gas acting on each of the separate small particles extracts the volatile constituents much more quickly, and as a result they are not broken down to anything like the same extent as in high-temperature carbonization in a coke oven, or indeed in some of the conventional low-temperature methods

The fine char that has been devolatilized in this fluidized process is a difficult material to compact and briquette, and a number of ways of doing this are under investigation The most promising involves the use of a binder, and since this binder, like the

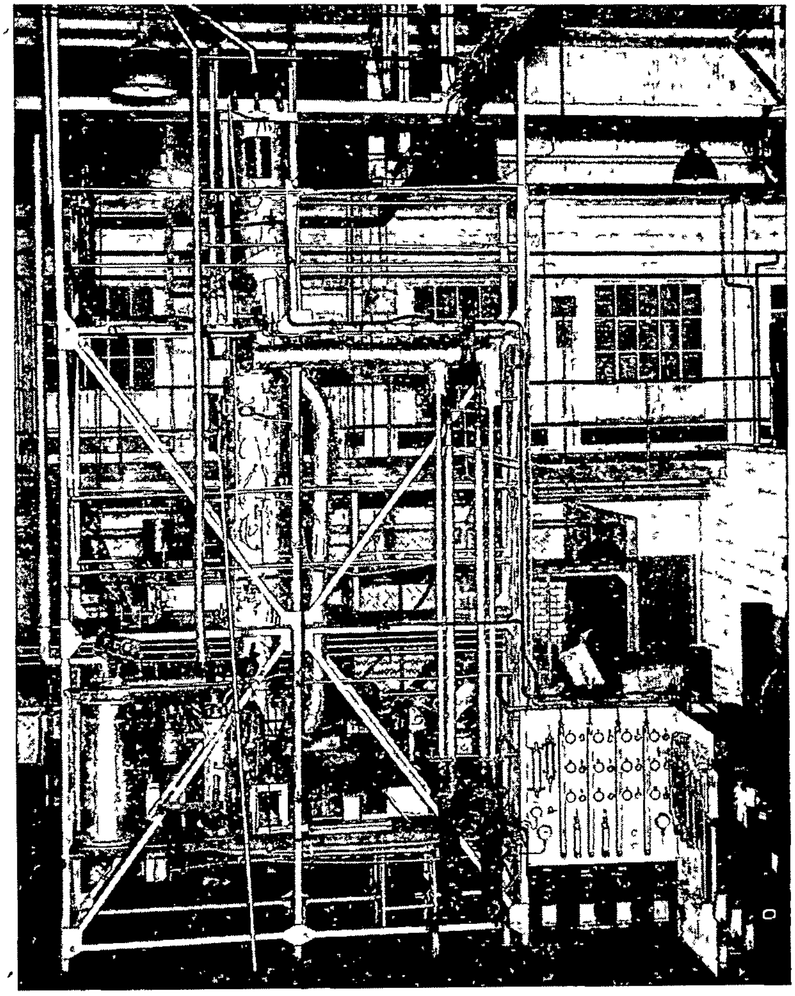


Fig 2. Experimental plant for combined devolatilization, briquetting and carbonization at Stoke Orchard

pitch used in the manufacture of 'Phurnacite', is smoke-producing, a second carbonization is necessary. Such multiplication of stages could not, of course, be contemplated using batch-wise operation with equipment composed of a large number of individual units, as in a coke-oven or 'Phurnacite' plant. This has been avoided in the first heating stage by using the fluidized method; but obviously another method has to be sought for treating the briquettes.

This major difficulty has been overcome by using a method of hot-sand carbonization. In this method the briquettes move through a single large vertical vessel much like a continuous vertical gas retort; but the essential new feature is that they are heated up to carbonizing point by a stream of red-hot sand that flows continuously around and past them.

The advantages of this new method of carbonization are great. First of all, it gives much more rapid carbonization, and therefore lower capital costs per ton carbonized per year. Secondly, it is a continuous process and gets away from the bogey of batch operation.

Fig. 1 shows the general flow diagram of the combined process of fluidized devolatilization, briquetting and final carbonization.

Finely divided coal goes into the large carbonizing vessel, from which come off the gas and liquid products. While still hot, the char is airborne into the briquetting stage, where it is mixed with pitch tar derived mainly from the second carbonization, but with some make-up from the first carbonization. The briquetting is carried out at a high temperature, and with the least possible loss of heat the briquettes go into the sand carbonizer.

Although it is impossible at this stage to give precise figures for the yields of the various products from the combined process, it seems likely that for every 1,000 tons of coal going in there would be produced about 660 tons of a clean uniform briquette with about 15 per cent of volatile matter. This fuel would be smokeless but would light with paper, and would give a bright, cheerful fire.

In addition to this solid fuel, there would probably be about 1,000 gallons of light oil, 4,000 gallons of diesel oil, and 15,000 gallons of pitch/creosote boiler fuel. The gas would practically all be used in supplying heat for the process; it is also an attractive feature that the plant would produce its own binder. It may be said, therefore, that the coal is carefully taken apart and reconstituted into two forms, uniform briquettes of controlled volatile matter and a liquid fuel.

There is still, of course, a long way to go before the process is in commercial operation. Its feasibility has, however, been established in experimental plant on a 50 lb./hr. scale, and good progress is already being made on the next stage, which is forty times larger—that is, one ton an hour. After that, the process will have to be carried to the pilot development stage of, say, 20–40 tons an hour through-put. Fig. 2 shows the 50 lb./hr. plant at Stoke Orchard.

In parallel with the development of the combined process just described, some further work at Stoke Orchard has been concerned with the ever-recurring difficulty that, in order to make smokeless lump fuel from the small coal of the really abundant reserves, it is necessary to go to all the trouble of putting in something sticky to hold the coal together, and then carbonize this to form a firm cement. The pitch that is frequently used is not only expensive, but also half its value is lost when it is carbonized.

Quite recently at the Board's Research Establishment at Stoke Orchard there has been discovered a simple method by which hard briquettes can be made from these high-volatile coals without using any binder at all. The briquettes made by this method can be carbonized, either in an ordinary oven or by the new process of sand carbonization, to give a final product of great strength.

This discovery has great potentialities and may revolutionize thinking on the whole subject of supplies to consumers, for if by a simple method it is possible to re-form coal from fine dust without having to fall back on the rather clumsy expedient of adding pitch, a considerable step has been made towards meeting the shortage of lump coal. The Board can face with equanimity a greater and greater production of fine coal, and can turn this into sized coal of whatever size the market demands.

The fact that this method provides a very simple way of making a strong coke of any reasonable size from a non-coking coal may be of great help in the future in removing anxiety concerning the reserves of the precious carbonizing coals.

In conclusion, it must be emphasized that all these developments are still only in the research stage. Difficulties and disappointments will be met, and the pattern of demand may have changed somewhat in a few years time; but even if the exact application of this new discovery cannot be foreseen, it seems certain that it constitutes a significant advance.

POWDER METALLURGY

POWDER metallurgy is an ancient art but a comparatively new science in spite of the fact that, for fifty years or more, metals of high melting point, such as tungsten, have been manufactured in massive form by the sintering of the metal powder. The development some thirty years ago of sintered metal carbides, initially for machine tools, opened up a field which rapidly assumed considerable importance in the engineering industries, and which has steadily expanded both in scope and in the nature of the sintered material. It was not until the Second World War, however, that powder metallurgy began to assume increasing importance for the manufacture of general engineering components and of alloys to precise composition and property specifications. In 1949 a symposium held in London directed attention to the ever-broadening scope of the industry and of the trends in its development.

The considerable progress which has been made, both in the science and practice of powder metallurgy, during the intervening years was clearly demonstrated at the second British Symposium held in London during December 1 and 2, under the auspices of the Iron and Steel Institute, in association with the Institute of Metals. A significant expansion in the manufacture of metal powders and in the diversity of components produced from them has been coupled with developments in manufacturing equipment and techniques, while both pure and applied research work has led to a better understanding of the basic principles on which the industry is founded.

A total of fifty papers was presented at the symposium, of which approximately 25 per cent were submitted from overseas. They were discussed in four half-day sessions under the following headings:

Group I Manufacture, Properties and Testing of Powders; Group II Principles and Control of Compacting and Sintering; Group III Manufacture and Properties of Structural Engineering Components; Group IV Powder Metallurgy of High-Melting-Point Materials.

The considerable interest in powder metallurgy was reflected in the attendance at the meeting, which attracted more than five hundred delegates, of whom approximately ninety came from overseas.

Manufacture, Properties and Testing of Powders

Developments during recent years in the manufacture of metal powders have been aimed primarily at reducing the cost, while improving the control and quality of the product. A significant trend is towards methods in which the powder is the direct end-product of the process of extraction of a metal from its ore, rather than in the disintegration and comminution of metal in bulk. The gaseous reduction of metal oxides, the reduction of iron oxide by an iron powder of high carbon content, electrolytic processes and the reduction of metal salts in solution by hydrogen at elevated temperatures and pressures are processes of increasing importance in this connexion. The manufacture of powders of ferrous and non-ferrous alloys by atomization is one of the most important developments in powder manufacture during recent years, particularly in view of its scope and comparative low cost.

The hydrogen reduction process has, for many years, been used in the manufacture of iron and iron alloy powders for magnetic purposes, particularly in the telecommunications industry. The control of the physical properties of the alloy powders so produced leads to a wide range of applications.

The physical properties of a metal powder, including the shape, density, surface condition and size distribution of the powder particles, have received special study in recent years, and considerable advances have been made in methods of examining these properties. The behaviour of brittle, tough and ductile metals on mechanical grinding leads to the interesting conclusion that, with soft metals, an equilibrium particle-size is reached irrespective of the initial particle-size used. While the control of quality of metal powders has undoubtedly improved as a result of investigations such as the above, there is still considerable scope for further study and for improvement, particularly when it is realized that surface films and absorbed gases can in themselves significantly affect the compacting and sintering properties of a metal powder.

Tantalum lamp filaments were made from the sintered metal at the beginning of the present century; recently this metal, together with zirconium and titanium, has assumed growing industrial importance. While arc-melting techniques are being developed for the latter two metals, tantalum, on the other hand, is likely to remain a product of powder metallurgy. Its extraction as a powder on a commercial scale, involving sodium or calcium reduction processes, is an interesting example of the scope of modern chemical engineering. Where titanium or zirconium is required in powder form, the metal sponge is embrittled with pure hydrogen and then ground. The absorbed hydrogen may be removed by sintering the compacted powder *in vacuo*.

Principles and Control of Compacting and Sintering

Excepting when liquid phases are present during sintering, sintered materials are porous. In certain cases, porosity may be deliberately encouraged, as in the manufacture of permeable bodies for filters, cooling units, porous bearings, etc.; for general engineering components, where the best mechanical properties are required, porosity is undesirable. One technique which has been developed to reduce this effect is to 'infiltrate' a permeable sintered metal skeleton with a molten metal of lower melting point.

Research work in the powder metallurgy field in recent years has paid particular attention to porosity in sintered components, either with the view of developing a theory of sintering, to control permeability where such a property is required, to note the effect of porosity on mechanical properties, or to study the process of infiltration. The mechanism of infiltration is similar to that of sintering in the presence of a liquid phase, where the primary property determining the processes involved is that of the free energy of the interface between the solid and liquid phases. The transference of the solid phase by a solution in the liquid phase determines the final structural condition obtained, which, in turn, will have a bearing on the mechanical properties of the component.

While the effects of re-crystallization and grain-growth on the progress of solid-phase sintering are clearly established, the mechanism of closure of isolated pores is still a matter of conjecture. Studies, however, of sintering in the presence of an active atmosphere, such as a halogen, which results in improved mechanical strength and ductility in sintered metals and a rounding off of pores, open up a new field of considerable scope. The use of a flux, either solid, liquid or gaseous, in order to ensure that true interparticle bonding is achieved during sintering is likely to enhance considerably the importance of powder metallurgy in the manufacture of general engineering components.

Studies of the nature in which uniform and non-uniform powder particles pack together are providing basic information on the properties of permeable sintered bodies. Perhaps, however, the most intriguing development work on the compacting of metal powders is that of the production of sheet or strip direct by the rolling of powder. Considerable success has already been achieved on an experimental scale with this technique, in which the compacted powder strip is eventually sintered to a density very close to that theoretically possible. This process, particularly if it can be coupled with sources of cheap metal powders, holds out considerable promise for the production of metal strip at very low cost.

The influence of the physical properties of metal powders on the mechanical properties of sintered compacts produced from them is not yet completely understood, although much information is being accumulated on this particular aspect. The difficulty, of course, is that there are so many properties of a metal powder particle which may have a bearing on the properties of the ultimate sintered component. Over and above this, the sintering atmosphere itself can play a most important part, and the choice of sintering conditions—either a controlled atmosphere or a vacuum—can, when everything else is under control, markedly influence the physical and mechanical properties of a sintered compact.

Manufacture and Properties of Structural Engineering Components

Various methods are employed in the manufacture of sintered metals for general engineering applications in order to reduce the porosity of sintered metal parts In general, sintered components show satisfactory mechanical strength but low ductility In recent years many investigations have been made of the effect of re-pressing and re-sintering on the strength and ductility of a wide variety of sintered metals and alloys Re-pressing and re-sintering increase the strength and ductility of sintered components, and it is reasonable to assume that this is achieved by improvement of the intergranular bond-strength by the breakdown of films, either solid or gaseous, which inhibit true bonding Re-treatments of this kind, however, are expensive and, undoubtedly, the use of a gaseous flux to ensure true bonding and hence satisfactory mechanical properties after one sintering operation only will figure prominently in future research work Investigations of this kind, undoubtedly, will also be related to improvements in the intergranular bond-strength in permeable bodies for turbine components, in which permeability plus high strength is required for parts which are maintained at a safe working temperature by means of a cooling medium such as air. The use of pre-alloyed stainless steel alloy powders for permeable components such as filters is now well established, but, up until now, such components have not met the strength requirements necessary for turbine components which are stressed in service

Permeable bodies have been used for some considerable time as oil-impregnated bearings, recent developments include the 'oilless' bearing materials, which consist of a porous metallic matrix impregnated with 'Fluon' The 'Fluon' is introduced into the porous skeleton either by hot pressing or via aqueous suspension, from which it is then sintered into the pores of the matrix Bearing materials of this kind run dry in corrosive conditions and permit the use of high surface speed when a liquid coolant is present at the bearing surface

Copper–lead bearings have been produced for many years by casting the alloy on to a steel backing This process is difficult to control, and the quality of the bearing material leaves much to be desired It is now possible to produce bearings of this type by a process in which the copper–lead is sintered on to a copper-plated steel strip, which can then be rolled to dimensional requirements and given a final sintering treatment High-quality bearings are produced in this way, and a study of the manufacturing process has contributed much useful information on the mechanism of sintering in the presence of a liquid phase

An important development in the powder metallurgy of light metals has been that of sintered aluminium containing a high but controlled percentage of aluminium oxide (about 13 per cent) The presence of the oxide results in creep and fatigue properties, at temperatures up to 400° C, superior to those of the best precipitation-hardened aluminium alloys Furthermore, the room temperature properties of the material remain unaffected after prolonged treatment at temperatures as high as 550° C Recent investigations have been concerned with the application of this principle to alloys of aluminium, and they show considerable promise Similar principles are being applied to the production of material of high-tensile strength from magnesium powder There is undoubted scope in the powder metallurgy of light metals, including perhaps titanium, for techniques similar to that developed for sintered aluminium

Powder metallurgy is now being used for the manufacture of alloys to precise composition limits in order to ensure close control over a particular property which may be sensitive to slight changes in the basic composition and to the presence of trace impurities In the electrical industry, certain alloys for sealing to glass are being made by powder metallurgy methods and the sintered alloy fabricated into strip or wire according to requirements Magnetic alloys of high permeability and low loss, based on nickel, are also being made by sintering followed by processing into strip. There is undoubted scope, particularly in the electrical industry, for alloys made in this way to precise composition limits

Powder Metallurgy of High-Melting-Point Materials

With the development of the gas turbine and the demand by the engineer for materials to withstand ever higher temperatures and stresses, it is of particular interest to note that one of the earliest groups of sintered products, namely, sintered carbides, is figuring very prominently in development work in this field Interest in this connexion centres mainly around titanium carbide for a number of reasons, including the fact that it is of relatively low density and has an encouraging strength at temperatures up to 1,000° C However, the resistance to oxidation of this material bonded with cobalt does not meet requirements, although the addition of other carbides, such as chromium, niobium, vanadium and tantalum, improve both the creep strength and the resistance to oxidation The high-temperature properties of these materials are determined largely by the properties of the matrix or bonding material, although it is considered that the primary carbide phase does influence the strength of the matrix. In this connexion, investigations into alternative bonding materials, such as heat-resisting alloys, indicate that creep strengths superior to those of the alloys themselves can be obtained However, the low impregnated strength and cold ductility, plus the difficulty of fabrication, are at present severe limitations on the accepted use of these materials for gas turbine components

In recent years considerable interest has been shown in alternative intermetallic compounds having high temperature stability, including silicides and borides of the transition metals Considerable investigations have been made in recent years on mixed metal–silicide systems Many of these compounds show exceptional resistance to oxidation at temperatures of 1,500° C or more, and recent studies have shown that this is due to formation of a protective oxide layer rich in silica Much further development work, however, will be required before compounds such as silicides are accepted for engineering applications, primarily because of their extreme brittleness and the ease with which they react with metals considered for bonding them

The possibility of manufacturing certain of the existing high-temperature alloys by powder metallurgy methods have been investigated These materials in the right condition normally depend upon complex carbides for the development of satisfactory high-temperature creep-fatigue resistance The introduction of carbides in the necessary concentration in the equivalent sintered alloy presents difficulties, due to reaction between the carbon and the oxide present in the metal powders used The possible solution here may be the use of alternative precipitates to carbides for the development of satisfactory high-temperature strength.

Metal – ceramic mixtures are a comparatively new field for research and development of materials for high-temperature service Metal-bonded alumina compounds figure quite prominently in the investigations which have so far been carried out Satisfactory bonding between the metal and ceramic is essential for strength at high temperatures, and basic studies of the wetting of ceramics with metals form an important part of research work in this field As in the case of titanium carbides, the work has shown that a thin layer of bond metal has much greater strength than that of the bond metal in massive form, and this is attributed to the inability of the thin layer of metal to deform plastically Increasing information is becoming available on the high-temperature properties of ceramics bonded with metals The optimum composition would appear to be in the neighbourhood of about 50 per cent by weight of the metal The interesting point of view has been expressed that for optimum properties and, in particular, good resistance to thermal shock, the metal network and the ceramic network should both be continuous I JENKINS

EDUCATION AND TRAINING OF RADIO ENGINEERS

THE present demand of industry and the Services for more radio engineers has emphasized the continuing difficulties of education and training in this field Following a series of reports made by the British Institution of Radio Engineers on this subject a recent meeting of the Institution in London was devoted to examining some of the present problems

Opening the discussion, Prof E E Zepler (professor of electronics in the University of Southampton) stated that there is now scarcely an industry which does not, in one way or another, use either electrical communications or what is now called industrial electronics The British Institution of Radio Engineers has recently decided to extend the syllabus of its graduateship examination by including industrial electronics as a specialized subject as from 1956

The universities have not, so far, final degree courses in radio engineering Many universities provide specialized papers in communications and radio physics, but all too few universities have, in fact, a chair of radio or electronic engineering In consequence, education and training in the universities are not a main contribution towards the solution of our man-power shortage and, in the main, recruitment in the industry comes through the technical college

Prof Zepler feels that universities which, for various reasons, will not cater for a degree in electronics might be prepared to provide a fourth-year course, devoted wholly to electronics, for those who have taken a degree in physics or in electrical engineering

Prof Zepler invited discussion on the question of whether industry co-operates sufficiently with the universities and technical colleges in providing sandwich schemes and part-time release.

He said that the experience of some of the examining bodies, including the British Institution of Radio Engineers and the City and Guilds of London Institute, was that examination results show that students are, in the main, inadequately prepared for these examinations, but suggested that the results are not wholly the fault of the technical colleges, it might well be that basic training at the grammar schools and secondary modern schools is not adequate

Prof E Williams (professor of electrical engineering in University College, Cardiff) said that he has no doubt that, at one stage of the country's educational development, classics provided the quickest and most readily available training in straight thinking But nowadays we must surely quarrel with the principle that "it doesn't matter what you teach so long as it trains a man to think" The practice of radio and electronic engineering now rests on so extensive a basis of specialized physical principle and of particularized application of mathematics that its study is as much a contribution to true education as is the study of any pure science The desirable limits of specialization are imposed, not by educational considerations, but by vocational requirements A very broad study of physical principle is undoubtedly needed, but Prof Williams holds that, in the limited time available, it is both unpractical and unnecessary to prescribe a similarly broad study of related technologies Professional institutions have not the same function as universities, and it is reasonable to expect greater specialization in courses leading to the examinations of the former. Prof Williams thinks that the development of education and training in radio and electronic engineering will be seriously retarded unless the policy of regarding 'electrical engineering' as a convenient indivisible unit of subject-matter is abandoned.

Mr Hugh Warren (principal of the South East London Technical College) represented the Association of Principals of Technical Institutes at the discussion He feels that the term 'radio' should not be restricted to the connotation with which it might have started many years ago Instrumentation, control, radio-frequency heating, radar and an ever-widening field of applications now have to be added to the fields of valve manufacture, telecommunications and recording and amplifying equipment

Mr Warren said that perhaps half the 250 or so technical colleges in Britain have seriously concerned themselves with the training of radio engineers Just as there is no British standard radio engineer, so there is no attempt to prescribe a single course There are many courses and they reflect the complexity and variety of this rapidly expanding industry They prepare for a wide variety of qualifications—degrees, diplomas, the National and Higher National Certificates, a number of different City and Guilds Certificates, and the examinations of the professional institutions. These fairly well-defined levels of qualifications blend into each other. Mr. Warren defied anyone to delimit the exact boundaries of a professional engineer He paid a tribute to the real co-operation both of organized industry and of individuals in industry, in the matter of courses and equipment After comparing British and French systems of apprentice-training, Mr Warren asked for guidance on the question of whether a new certificate in radio is needed. In mechanical engineering there is a certificate for those who are not going to be designers, but are going to be very good technicians, if not technologists. There is nothing quite comparable in radio. Mr. Warren wondered whether the technical college should, as in France, undertake more of the practical side of apprentice-training—or whether industry is content to undertake this. He concluded with a plea that education should find room for social thinking and an awareness of the economic and philosophical problems of our age.

Mr. R. E. Burnett (manager of the Education and Technical Personnel Department of Marconi's Wireless Telegraph Co.), expressing personal views, maintained that the radio industry is playing a full part in co-operation with the universities and technical colleges in stimulating recruitment and in planning the future training and education of radio engineers.

Agreeing that there is still a tremendous shortage of professional engineers in this field, Mr. Burnett stated that the larger companies are spending more and more money in developing their own training schemes, including the provision of the equivalent of college facilities. The smaller, but progressive, firms are in many cases making a proportional contribution to the problem of providing adequate training by co-operating with local technical colleges and in some cases making arrangements with the larger companies who are able to provide their own schemes. He advocated that there might be an extension of this principle in view of the increasing number of organizations which are not at present in a position to set up their own individual training schemes.

Agreeing with Mr. Warren that the question of selection is important, Mr. Burnett feels that too little is done to help the student who fails to reach professional status or even Higher National Certificate level. He advocated that courses and examinations should be so organized as to enable the candidate who cannot reach the higher level to be accommodated in the technician or craft level. Similarly, not enough is done to encourage the successful craft apprentice to go forward to secure professional status.

Some graduates hold the view that, having completed their university training, it is not necessary to follow on with a form of training or apprenticeship course. Most of the larger companies, however, have found that it is to the ultimate advantage of the graduate to undertake further training in the shape of an apprenticeship course, if only to have a first-hand understanding of the working of the various departments which go to make up a large organization. The graduate who leaves the university and is straightway employed on a special task tends to become insular in his outlook and not to use fully his academic training.

In general, the output of the universities is so comparatively small that industry is compelled to look to the technical colleges and the other examining institutions for recruitment to its professional ranks. In return, industry must be conscious of the need for arranging sandwich and similar courses (at present in very small numbers) in order to provide adequate training facilities for able young men who, for one reason or another, cannot undertake a full-time university course.

Other speakers in the discussion dealt with the shortage of teachers. Too many technical colleges are dependent on the services of the part-time lecturer who, by reason of his main job in industry, is unable to give adequate time and thought to teaching.

Mr. E. M. Wareham (chief engineer of Sanders Electronics, Ltd.) feels that there is a serious gap between the standard of training of a university graduate in electrical engineering or physics, and the standard required in the design and development laboratories. The average student has to have at least two years training and general experience before being entrusted with responsible electronic work in the design and development field.

Mr. C. W. Robson (head of the Electrical Engineering Department of the South East London Technical College) feels that very few firms are prepared to enter into an apprenticeship scheme which will give the technical colleges the maximum opportunity of playing their part in the thorough training of the younger man.

The technical colleges are, in the main, dependent on recruitment at the age of sixteen or seventeen years, when the work of the technical college has to be integrated with the activity of the employing firm. In the Ordinary National Certificate, Mr. Robson feels that there should be greater specialization in radio and electronics.

Other speakers expressed the view that industry, and particularly the radio industry, does not do sufficient to publicize in the schools the opportunities available in industry. The first contribution made by the radio industry in this connexion is the excellent booklet distributed by the Ministry of Labour on radio and electronics as a career.

It was suggested that a difficulty in persuading youth to go in for a radio engineering career is the fact that, in the first two or three years of technical college training, students are confined to training in electrical engineering. Mr. W. Dunn expressed the belief that, if the radio apprentice could, in his first three-year technical college course, secure acknowledgment and reward in the shape of an Ordinary National Certificate in Radio Engineering, his interest would be much better maintained than under the present arrangement of expecting him to take an ordinary National Certificate in electrical engineering before starting any serious study of radio and electronics.

E. WILLIAMS

OBITUARIES

Sir Shanti Bhatnagar, O.B.E., F.R.S.

ON New Year's Day, India lost a great public servant, Sir Shanti Swarup Bhatnagar, a man of exceptional ability and immense energy. As director of the Council of Scientific and Industrial Research, secretary of the Ministry of Scientific Research, and chairman of the University Grants Committee, he was the Prime Minister's right-hand man in implementing the policy to put science in the forefront of India's plan for the future. When inaugurating the forty-second session of the Indian Science Congress at Baroda on January 4, Mr. Nehru paid him tribute: "I have co-operated for the last six or seven years or more with Dr. Bhatnagar who, I think, has done—I say this with all respect due to others—more than anyone else for scientific development in India".

Twelve new national institutes and laboratories have been built, equipped and established in various centres in India* during the past six years, and most of them are now in full operation. Anyone who has seen these institutes cannot but be astounded by the energy and drive of the man who in so short a time created them Bhatnagar could well be called a master builder, for there is a unity of conception, and every detail, even the fountains in the gardens, had some special object emanating from his ideas In the words of Dr. H. J Bhabha, "in the short space of a few years Bhatnagar built the laboratories which are indispensable to any nation which aspires to leadership in the modern world, and he has provided the means whereby young Indian scientists of to-day and to-morrow can make their contribution to the betterment of India and its people" These laboratories will be an enduring monument to the imagination, enthusiasm and patriotism of Bhatnagar, who spared himself not at all He travelled far and wide to seek the latest designs, the most suitable equipment, the recent techniques which would help to promote the efficiency of his laboratories. He was undeterred, he went ahead and got things done—he did not permit finance to baulk his objectives and yet they were achieved at remarkably reasonable cost owing to his exceptional foresight and ingenuity.

Although this chain of laboratories is Bhatnagar's great achievement, it absorbed only part of his energies as secretary of the Ministry of Scientific Research and as director of the Council of Scientific and Industrial Research with its numerous committees and activities He was the mainspring of it all, and he had his finger on every detail of the Council's work. He possessed a clear, concise and well-docketed mind He was the first to arrive at the secretariat and his light was the last to go out, driving his assistants hard, he drove himself harder He had a kind heart and a keen sense of humour, and they appreciated the joy and privilege to work for him.

As chairman of the University Grants Committee, he had undertaken a further great and important ask Sir A L. Mudaliar, vice-chancellor of the University of Madras, stated that "Bhatnagar had just got into full stride as Chairman and it was a reat misfortune that at this stage the Commission should be deprived of his forceful personality, and his wisdom and guidance".

Alas, the strain of all this work for India and for science was too great, and in his sixtieth year his eart suddenly failed.

Bhatnagar was born in a small township near Delhi in 1895—the Prime Minister was present at his birthday celebrations held at the National hysical Laboratory (Delhi) last February—and the evotion accorded to him and the respect for his achievements must have pleased him. His father as a teacher at Bhera in the Punjab, but he died hen Bhatnagar was only eight months old. He often spoke of his mother and the great influence she had on him during his early days at school, when with considerable struggle but great innate ability he managed to acquire the knowledge for entry to the Forman Christian College, Lahore. There he came under the influence of able professors, and took his M Sc. in chemistry in 1918 in the University of the Punjab. In 1919 he came to England and obtained admission to University College, London, where he worked under Prof. F G Donnan, for whom he had great esteem and affection. In 1920 he obtained a grant-in-aid from the Department of Scientific and Industrial Research and continued working on the stability and inversion of oil–water emulsions, and secured the D Sc, University of London, in 1921 After that he spent some months in Europe, at the Sorbonne and at the Kaiser Wilhelm Institute (Berlin), and was then appointed professor of chemistry in the Benares Hindu University, where he remained until 1924, having started a centre of physical chemical research In October 1924 he became professor of chemistry and director of the University Chemical Laboratories, University of the Punjab, Lahore, which post he held for sixteen years. This was his most active and fruitful period of research, during which he published many papers on physical chemical subjects—colloids, surface chemistry, photochemistry, and particularly magneto-chemistry He published, with K. N. Mathur, "Principles and Applications of Magneto-Chemistry", and devised with him an interference balance for magnetic measurements His research in magneto-chemistry gained him election to the fellowship of the Royal Society of London in 1943.

Bhatnagar was, from all accounts, a very inspiring teacher, it was as a teacher that he himself was most happy. He took great trouble about his pupils, and many were the unbeknown acts of kindness and generosity Not only was he a teacher of chemistry with a power of original work, but also he was widely read, and a gifted writer His Urdu poetry, which was cast in a light vein, was much appreciated. His interests were wide, he was gay in conversation, lively in debate, and a wonderful friend He had an unprejudiced outlook, having travelled widely and having many friends in many countries Albeit, he was a great patriot and ambitious for India's sake

In 1940, Lord Linlithgow (then Viceroy of India) was looking for a man to help to establish a government organization on the lines of the Department of Scientific and Industrial Research in Great Britain. He wisely chose Bhatnagar. Thereafter Bhatnagar became more closely linked with the Government machine at Delhi. It would have been difficult anywhere to find a man of more varied accomplishments, with such energy and drive. He had already had close connexions with industry. During his time at Lahore, he had devised processes relating to the purification of kerosene oil which proved helpful to Messrs Steel Bros It was characteristic of Bhatnagar to turn over emoluments received to public benefit, and he arranged with the company to found the Steel Bros. Research Scheme, which could be employed for research scholarships in the Punjab University Chemical Laboratories Such schemes were extended when further ideas led to support for research from other oil industries.

It was in connexion with his activities while still at Lahore that he was made O B E in 1936. He was knighted for his services on behalf of the Government in 1941

During the Second World War and in connexion with the work of the Council of Scientific and Industrial Research, Bhatnagar's ideas fertilized many activities—for example, the production of anti-gas cloth and varnishes, foams, vegetable oil blends as substitutes for lubricating oils, glass substitutes, synthetic resins and plastics from waste products He was the owner of a number of patents relating to textiles, wood products, mineral waxes, etc He was in touch with all the chief industrialists in India and had connexions with many leading technologists in other countries, furthermore, he was skilled in negotiation, so that, with his experience in university life and his many personal scientific friends, he became invaluable as the centre of the growing scientific organization within the Government of India When national independence came, the schemes on which his heart was now set quickly took shape Some of them, indeed, had already been decided (for example, the building of a National Physical Laboratory)

---

* National Physical Laboratory of India (Delhi), Central Road search Institute (Delhi), Central Building Research Institute oorkee), National Chemical Laboratory of India (Poona), Central od Technological Research Institute (Mysore), Central Electro-emical Research Institute (Karaikudi), Central Leather Research titute (Madras), Central Glass and Ceramic Research Institute lcutta), National Metallurgical Laboratory of India (Jamshedpur), ntral Fuel Research Institute (Dhanbad), Central Drug Research titute (Lucknow), Central Salt Research Institute (Bhavnagar)

Bhatnagar took a leading part in starting a number of projects, such as the formation of Indian Rare Earths, Ltd., for the processing of monazite sands and the search for atomic minerals. A number of metallurgical and chemical processes were developed or changed to suit Indian conditions and India's needs, for example, the enrichment of manganese ores proved a valuable enterprise.

His administrative successes were frequent, it may be mentioned that he was successful in gaining exemption from tax for expenditure on research, and from customs duties on scientific instruments essential for research He was active in promoting the regional technological institutions, the Standards Institution and the National Research Foundation, and was a very useful member of the Council of the Indian Institute of Science, Bangalore. He instituted a documentation centre which was accommodated in the National Physical Laboratory building

Bhatnagar took a lead in all that was going on in science in India Before the War he had been sectional president (chemistry) of the Indian Science Congress (1928 and 1938). He was general president in 1944–45. He was president of the National Institute of Science of India (1947 and 1948), and as president in his address at the thirty-sixth session of the Indian Science Congress, he appealed to the young scientists of India for zeal in the cause of science and its application and zest for research

He attended many conferences in foreign lands, as representative of India He was a delegate to the Empire Universities Congress at Edinburgh (1931) and at Cambridge (1936), to the British Association and the Michael Faraday centenary celebrations (1931), and at the Liverpool meeting so far back as 1923. He was a member of the Indian Scientific Mission for the Government in 1945 and leader of the official delegation at the Empire Scientific Conference in 1946, and a member of the Indian Atomic Energy Commission which visited Great Britain in 1948. He attended the United Nations Scientific Conference on Utilization and Conservation of Natural Resources in New York, 1948 He made many tours to Europe and America in connexion with his work, and these included recently visits to the U S S R. and to South America

Bhatnagar was an honorary D Sc, Oxford (1946), and had received the honorary doctorate of Delhi, Allahabad and Patna, and was honorary professor of chemistry of the Universities of Delhi, Benares and the Punjab He was a Fellow of the Syndicate and member of Council of Benares University He was a Fellow of University College, London. He was a Fellow of the Institute of Physics and of the Royal Institute of Chemistry (London), and was made an honorary member of the Society of Chemical Industry (London) in 1943 and honorary vice-president (1945–48) He was a past-president of the Indian Chemica Society and recipient of the Reddy Prize in Chemistry 1947

The joy of Bhatnagar's full, eager life was marred by the loss of his wife, Srimati Iajwanti, in 1945. He had two sons and two daughters A son and daughter-in-law lived with him, and his home-life was still a happy one. He had a little farm outside Delhi in which he took great pleasure But one could not imagine his tireless soul resting at ease in this world while there was work to be done Providence ordained that he should suddenly be taken away so that others, by the very shock of his loss, may be fired with his zeal. He has provided the means fo scientists in India in many branches of science to d great work ALFRED C. EGERTON

Dr. G F. C Searle, F.R S.

A MEMORIAL service for the late Dr G F. C Searle, a former Fellow of Peterhouse, Cambridge who died on December 16, was held in the College Chapel on January 21, at which colleagues, forme pupils and friends gathered as a tribute to the passing of a notable personality.

Searle was the son of the late Rev. W G Searle and was born in the vicarage at Oakington, Cambridgeshire, on December 3, 1864 His ninetieth birthday was celebrated by a tea-party at the Cavendish Laboratory on December 3 last, when a large and distinguished company heard him give an account o his boyhood and youth, and of his introduction t physics when taken by his father to see the newly erected Cavendish Laboratory and shown over the building by James Clerk Maxwell, then recently appointed the first Cavendish professor of experimental physics.

Searle won a foundation scholarship at Peterhouse and, entering the University, read for the Mathematical Tripos, which he took in 1887, being classed as a Wrangler In the following year he studied physics for Part II of the Natural Sciences Tripos He began research work in 1888 in collaboration with Prof J J Thomson on a determination of the rati of the electromagnetic unit of electricity to the electrostatic unit, a research which was published i the *Philosophical Transactions of the Royal Society* This was followed by many independent publications mostly dealing with magnetic measurements o electromagnetic theory, but occasionally with properties of matter or heat. These researches gained fo him the fellowship of the Royal Society in 1905 an the award of the Sc D degree by the University o Cambridge in 1912

Searle was appointed to a University demonstratorship in 1890 and to a University lectureship in 1900 He retired from both posts in 1935. A the outbreak of the Second World War, however, h returned to work again and only gave up finally, an with reluctance, at the age of eighty-three, havin then worked under three Cavendish professors S J J Thomson has placed it on record in his book "Recollections and Reflections", that "Searle ha done more for the teaching of practical physics a Cambridge than anyone else". He taught a larg class in practical physics at the Cavendish Laborator —that for students working for Part I of the Natura Sciences Tripos—and for more than forty yea nearly every Cambridge man taking physics was a some time his pupil. On the occasion of his ninetiet birthday party, Searle claimed with pride to have taught more Fellows of the Royal Society than any other teacher, and also that both the father and the mother of the present Cavendish professor had been his pupils

As a University lecturer Searle gave regular courses of lectures for Part II of the Tripos in classical electricity and magnetism and in heat He also, for a time, gave lectures on mathematics for students of physics. But it was his work as a demonstrator which gave him his pre-eminence He showed great skill in devising laboratory experiments suitable for instructing students, and in designing the necessary apparatus It is these skills which have carried his name and his teaching methods into the physics departments of almost every university and technical college in the world, and into the science laboratories of most progressive schools His experiments were never commonplace, their originality and elegance made a special appeal to students, so that they became keen to try them With each experiment he supplied a manuscript, written in his own hand, giving an account of the underlying theory, followed by a very full and clear description of the way the experiment should be made Some of these manuscripts have been published by the Cambridge University Press in a series of volumes Displayed on the notice-board of his laboratory was a list of instructions and exhortations to students beginning work in practical physics To many, the last paragraph of these was the most interesting. It dealt with the relations between students and their hard-worked demonstrators, exhorting students not to become annoyed if they did not get all the attention to which they felt entitled, but to be patient and remember that "demonstrators are only human and need your sympathy and your prayers at least as much as other men"

Dr. Searle married, in 1904, the widow of Mr. Thomas Parsons, of Wimbledon, and would speak most feelingly of the great help and constant encouragement he had received from her throughout their happy married life. He was above all a staunch Christian He was active as a lay reader of the Church of England and keen and enthusiastic about any duties he undertook. As a teacher his manner was perhaps rather brusque and a little forbidding to students meeting him for the first time, but his obvious earnestness and lively interest in them and their work soon overcame this, and he was held in respect and admiration by a large circle of students and friends FRANK HORTON

NEWS and VIEWS

Rothamsted Experimental Station: Dr R. K. Schofield

THE appointment of Dr R K Schofield to be head of the Chemistry Department of Rothamsted Experimental Station, in succession to the late Dr E. M Crowther, is a tribute to his versatility He went to Oundle School and won an entrance scholarship to Trinity College, Cambridge, in science and mathematics He took physics, chemistry and botany in Part I of the Natural Sciences Tripos, and his progress was marked by the winning of a senior scholarship and a first class in Part II (Physics) His special interest in the borderland between physics and chemistry led him to do his Ph D research on the physical chemistry of surfaces under Sir Eric Rideal For two years he was lecturer in physics at Durham and then joined the Physics Department at Rothamsted, of which he became the head in 1947 in succession to Sir Bernard Keen He is a recognized authority in the moisture relationships and colloidal aspects of soil, and in recent years has been particularly active in applying and extending the concept of the diffuse electric double layer He has been chairman of the Colour Group of the Physical Society and was visiting professor of soil physics at Cornell University during the winter of 1951–52.

Dr H L Penman

DR SCHOFIELD is succeeded as head of the Physics Department at Rothamsted by Dr H. L Penman, who graduated in the Newcastle Division of the University of Durham in 1930 with a first in physics After research in acoustics with Dr E. G Richardson, he joined the Photochemistry Section of the British Cotton Industry Research Association in Didsbury, leaving in 1937 to go to Rothamsted. Until 1941 he worked on diffusion of gases and vapours in soil, soil temperature, and on drainage and evaporation During 1941–44 Dr. Penman was in the acoustics section of the Mine Design Department, Admiralty, at Portsmouth In 1944 he returned to Rothamsted to resume his evaporation studies, and since then has been able to show that the use of water by vegetation is a physical process the rate of which is dictated by weather, and is calculable from weather data. The general utility of this work in irrigation control and in hydrology led to an invitation from the Waite Agricultural Research Institute, Adelaide, to spend six months in Australia (1951–52), where, supported by a Nuffield Fellowship, Dr Penman was able to study the water conservation and irrigation problems of south-east Australia. Dr Penman has been honorary secretary of the London Branch of the Institute of Physics, has served on the board of the Institute, and at present is an honorary secretary of the Royal Meteorological Society and a vice-president of the Association Internationale d'Hydrologie Scientifique.

Zoology at Fordham University: Prof A A. Wolsky

PROF. A. A WOLSKY, former professor of zoology in the University of Budapest and director of the Hungarian Biological Research Institute at Tihany, has been appointed professor of experimental embryology in Fordham University, New York. Following his formal education in Budapest, Dr. Wolsky did postgraduate work abroad under fellowships from the Hungarian Government, the Rockefeller Foundation and the Swedish Institute of Cultural Exchange This included studies in London in 1931, Cambridge in 1934, and at the Wenner Gren Institute, Stockholm, in 1935. In 1947 the Hungarian Government permitted him to return to Stockholm for a year At the end of that period he refused to return to Hungary He joined Unesco as principal scientific officer for South-East Asia, stationed at Djakarta Indonesia He has held that position for six years Dr Wolsky is the author of

"Genetics and the Origin of the Species" and "Biological Lexicon" His published papers deal largely with problems of experimental embryology and embryological genetics

The Canadian Defence Research Board

MR. E LL. DAVIES, vice-chairman of the Canadian Defence Research Board, has resigned and has been succeeded by Mr. A. H. Zimmerman, a prominent Canadian engineer. Dr G. S. Field, formerly scientific adviser to the Chief of the Naval Staff, has been appointed chief scientist Dr. N. W Morton, chief of the Division involving operational and medical research, human resources and environmental protection, and Dr. John W Abrams, superintendent of the Board's Operational Research Group, have been appointed scientific advisers to the Chief of the General Staff and the Chief of the Air Staff, respectively. Dr. F. H. Sanders is to become scientific adviser to the Chief of the Naval Staff. Mr G. M. Carrie, whose Division is concerned with special weapons and northern activities, and Dr J. J. Green, chief of the Division which directs activities in the fields of armaments and aeronautics, will combine with their present duties the task of increasing and reorganizing the headquarters' scientific staff. Dr William Petrie has been appointed acting superintendent of the Operational Research Group

Shipbuilding Research in Britain

A MEETING of the Parliamentary and Scientific Committee on December 7 was addressed by Mr Charles Connell, chairman of the British Shipbuilding Research Association, and by Dr. S. Livingston Smith, the director of research, on recent developments in research and technology in the British shipbuilding industry. Mr Connell, who limited himself chiefly to questions of policy, pointed out that British shipbuilding has a long history of technical progress and cannot be accused of backwardness in applying scientific ideas It should be remembered, moreover, that a ship and its machinery represent a capital investment of the order of £1 million with a working life of more than twenty years Mr. Connell, however, is concerned about the question of publication of research results, and urged that results likely to benefit industry should only be communicated to British industry in the first instance. In shipbuilding research, the policy is to send all research results first to member firms in confidence, and later the commercial advantage of each report is assessed on its merits before a decision about publication is taken. Mr Connell also pleaded for further financial support from the Government for the Research Association, in view of foreign competition

Dr. Livingston Smith, in his paper, gave some details of the work of the Association, much of which is undertaken extra-murally and on board ship The Association has shown that reductions of up to five per cent in frictional resistance of a ship's hull can be obtained by a better finish on the painted surface, and tests at Glengarnock on full-scale components of ships' structures have led to improvements in construction and large savings of steel A comprehensive series of tests of propulsion and resistance carried out in ship-model testing tanks on a range of models of ocean-going merchant ship forms have yielded data of great value to designers, and investigations on noise have led to the adoption of less expensive methods than that of acoustic lining in the engine room and elsewhere. Investigations into the causes of crankcase explosions and their prevention promise to reduce considerably this hazard.

Nuffield Foundation : Ten Years Grants

THE Nuffield Foundation has now published the second part of its review of its first ten years (pp. 319 The Foundation, London, 1954), which was promised when the review of the main policies pursued and the kinds of work supported was issued in 1953 (see *Nature*, 171, 851, 1953) In doing so, however, that admirable first part has been incorporated in the appropriate sections of this report, so that this new volume gives a more detailed record of the grants themselves and the progress made, to which are appended complete lists of Nuffield Foundation Fellows, Scholars, Bursars, etc, appointed during the first ten years and published research attributed, in whole or in part, to the Foundation's grants and awards, in this way it provides a clear guide to the policies pursued and the principles determining grants. The first part is thus entirely superseded by the second save only where it may be a convenience to have the general account run consecutively and unbroken by detail. Be that as it may, this report on grants made during the ten years April 1943–March 1953 will stand on its own as an authoritative and well-arranged reference work on the Foundation's activities during that decade There is an adequate index. This admirably written account of the way in which the private and independent institution can still function in the Welfare State provides a most impressive vindication of the principle of voluntary action.

Fellowships, Scholarships and Bursaries

THE Nuffield Foundation is offering a number of scholarships and bursaries for postgraduate training in biology and sociology. Those in biology are intended for graduates in physics, chemistry, mathematics or engineering, those in sociology for graduates in the natural sciences and the humanities Applicants should be 22–35 years of age and normally resident in the United Kingdom. The scholarship is valued at £500–600 a year (plus fees), with certain allowances for married holders, a bursary is valued at £350 a year (plus fees), also with certain allowances. Applications for the biological awards must be made by April 1; those for the sociological by May 1 The Foundation is also offering fellowships and scholarships in dentistry in order to enable holders with dental qualifications to receive such additional training in pure and applied science as is desirable to fit them for an academic career in dentistry or to assist university graduates in medicine or science in receiving training which will qualify them to undertake teaching and fundamental research in dental health and disease. A fellowship is valued at £500–800, with travelling expenses, a scholarship covers tuition fees and a subsistence allowance of up to £200 a year. Applications for fellowships must be made by March 1, those for scholarships by June 30. Further information can be obtained from the Director, Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W 1.

Statistical Methods in Industry

THE International Statistical Institute has just begun publication of the *International Journal of Abstracts on Statistical Methods in Industry* (annual subscription 2 50 dollars (18*s* or 9 50 guilders), from the Institute, at 2 Oostduinlaan, The Hague, Netherlands), and three issues have now appeared. This bibliographical work is to appear three times a year and each issue will contain about a hundred abstracts of papers on the application of statistical methods in industry and technology published in all parts of the world. It is the intention of the editors to prepare the abstracts in such a manner that the reader will be able to judge whether or not the original article would be of interest to him. 'Industry' will be interpreted broadly to include transport, mining, generation of electric power and management problems in agriculture (but not agronomy). Theoretical papers that have direct industrial and engineering applications will be included. The abstracts will be in English or in French, and printed on one side only of thin cardboard, so that they can be cut out and filed as 3 in. × 5 in. cards. Industrial statisticians who are willing to co-operate in the preparation of abstracts are invited to communicate with the appropriate regional editor; for the United Kingdom, he is Dr. E. H. Lloyd, Department of Mathematics, Imperial College of Science and Technology, London, S.W.7.

Decay of Wood in Boats

BULLETIN No. 21 of Forest Products Research, Department of Scientific and Industrial Research (London: H.M. Stationery Office, 1954), deals with "Prevention of Decay of Wood in Boats". In the days when all ships and boats were built of wood, the problem was a serious one because the nature of the decay was not understood and so no prevention or cure could be applied. In the eighteenth and nineteenth centuries naval authorities were seriously alarmed at the rapidity with which timbers in wooden battleships deteriorated and many remedies were tried without success. During and since the Second World War the problem has again become prominent owing to the increasing number of less-durable timbers in use. This bulletin is the result of a discussion between naval architects, representatives of boat-building firms and officers of the Forest Products Research Laboratory. As would be expected, the decay is found to be most serious in vessels which are laid up for parts of the year or are held in reserve. The bulletin describes with diagrams the fungi responsible for this decay and the conditions under which they develop. The decay is frequently alluded to by the term 'dry rot', which is caused by the fungus *Merulius lacrymans*. The name should be avoided, as this fungus is seldom found on a boat. The commonest wood-destroying fungi known to occur in boats are *Coniophora cerebella* (the cellar fungus) and species of the genus *Poria*. Methods for eradicating decay and preventing its development in new craft by the use of naturally durable timbers and modern wood preservatives are outlined.

Oil Palm Research

WITH the appearance of the second number of the *Journal of the West African Institute for Oil Palm Research* (September 1954), this new publication may be said to have got fairly into its stride. It promises to be of great value to all who are concerned with this important tropical crop. It combines in a useful way up-to-date investigations both of an applied and of a more fundamental character, while the critical reviews of other publications relating to oil palm matters seem likely to confer on the journal a centralizing and integrating function. The present number includes articles on the improvement of natural palm groves—an important domestic consideration in Nigeria, where most of the palm oil comes from this source—and the effect of cultural treatments on losses in the nursery. A sound foundation for future work on the diseases of the oil palm is provided by a preliminary account, with descriptions, illustrations and diagnostic key, of all the diseases thus far encountered in Nigerian territory. As the oil palm is often grown on somewhat, or even highly, impoverished soils, deficiency diseases assume a considerable magnitude from the point of view of both production and research. One of these diseases, described as orange frond, has now been shown to be due to magnesium deficiency and can be remedied by appropriate treatment. A further article relates to two new caterpillar diseases which may cause considerable destruction of palms.

Zoological Nomenclature

As from July 31, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of the plenary powers for the purpose specified against each entry. Full particulars of these cases have been published on January 31, 1955, in Parts 1 and 2 of vol. 11 of the *Bulletin of Zoological Nomenclature*. (1) *Pleurotomaria* Sowerby (J.), 1821, validation of (if judged to be invalid); *anglicus* Sowerby (J.), 1818 (*Trochus*), validation of, and designation of, as type species of *Pleurotomaria* (Cl. Gastropoda); (2) *Pachyceras* Bayle, 1878 (Cl. Cephalopoda, Order Ammonoidea), validation of; (3) *Neanura* McGillivray, 1893, and *Hypogastrura* Bourlet, 1839, designation of type species for; *Achorutes* Templeton, 1835, suppression of (Cl. Insecta, Order Collembola); (4) *Crenophilus*, validation of, as from d'Orchymont, 1942; *aeneus* Germar, 1824 (*Hydrophilus*), validation of (Cl. Insecta, Order Coleoptera); (5) *Rhinopteraspis* Jaekel, 1919, validation of (Cl. Ostracodermi); (6) *Anurophorus* Nicolet [1842], designation of type species for (Cl. Insecta, Order Collembola). Attention is directed also to the proposed suppression of the generic name *Jumala* Friele, 1882, as a name calculated to give offence on religious grounds. The above Parts also contain proposals for the adoption of three 'Declarations': (*a*) relating to transliteration of words normally written in Cyrillic characters (preliminary to insertion in the Code as a schedule (Copenhagen decision)); (*b*) defining the status of a generic name published conditionally; (*c*) clarifying Rule (*f*) in Article 30 (type species of a nominal genus established as a substitute for a previously established such genus but with a different type species). Comments on the above cases should be sent as soon as possible to Mr. Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

The National Science Foundation, Washington

THE National Science Foundation, Washington, has announced 216 grants totalling about 2,650,000 dollars for the support of basic research in the natural sciences, for conferences and studies on science, scientific information exchange, for scientific manpower, and for travel of American scientists to international scientific meetings. This is the first group of awards to be made during the fiscal year 1955 by the Foundation for the support of basic research and related matters. Since the beginning of the programme in 1951, more than 1,100 such awards have been made, totalling about 11,141,000 dollars. In addition, the first grant, totalling 100,000 dollars, was made under a special appropriation for the International Geophysical Year. The research fields included are astronomy, chemistry, developmental biology, earth sciences, engineering sciences, environmental biology, genetic biology, mathematical sciences, molecular biology, physics, psychobiology, regulatory biology, and systematic biology. A list of the grants, including institution, name of principal scientist, title, duration and amount, can be obtained from the Secretary, National Science Foundation, Washington 25, D.C.

Ulster Folk Museum

THE *Museums Journal* of December 1954 announces that the Committee appointed by the Northern Ireland Minister of Finance has recommended in its report that an Ulster Folk Museum be established in the grounds of Belfast Castle at a probable cost of £60,000. The Museum would consist of buildings, implements and other objects displayed in a natural setting and under living and working conditions. Buildings of a traditional type would be rebuilt or copied and so far as possible put to their original use. The Committee suggests that the Museum should be established on a national basis, with substantial Government financial backing. The Corporation of Belfast has already agreed to make available at a nominal rent some 5½ acres in the grounds of the Castle.

Leicester Museum and Art Gallery

THE forty-eighth report of the Committee of the Leicester Museum and Art Gallery records the opening to the public of the herb garden and Deacon Clock workshop in Castle View. The new garden and the reconstruction illustrating one of Leicestershire's oldest industries provide, on the site of what was formerly a builder's yard, an amenity which has transformed this corner of old Leicester. The report is issued in an attractive form, and interesting acquisitions are recorded.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: A. L. Job (inspector of mines, Tanganyika), inspector of mines, Uganda; R. B. J. Deane, tea officer, Agricultural Department, Mauritius; K. G. Windsor, agricultural officer, Northern Region, Nigeria; B. J. Gee, fisheries officer, Northern Region, Nigeria; R. G. Dixon, assistant conservator of forests, Federation of Malaya; A. W. Gunthert, mineralogist, Federation of Nigeria; A. G. Royle, inspector of mines, Tanganyika; J. A. Armstrong, entomologist, East Africa High Commission; J. B. Davies, entomologist, Sleeping Sickness Service, Northern Region, Nigeria.

Planned Parenthood

THE fourth International Conference on Planned Parenthood was held at Stockholm during August 17–22, 1953, at the invitation of Riksforbundet for Sexuell Upplysing (National League for Sex Education) and was attended by 158 delegates and observers from twenty-one countries. A report on the proceedings has now been published and includes papers on such topics as world population trends and their relation to food supplies, current experiments in birth control, termination of pregnancies, sterilization, subfertility, sterility, artificial insemination, marriage counselling and sex education. Great Britain was represented on the organizing committee by Mrs. Margaret Pyke and Dr. Helena Wright on behalf of the Family Planning Association. This interesting and informative report may be obtained from the International Planned Parenthood Federation, 69 Eccleston Square, London, S.W.1, price 10*s*. 6*d*.

Symposium on Condensation Nuclei

A SYMPOSIUM on atmospheric condensation nuclei will be held in the School of Cosmic Physics of the Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin, during April 26–28. Papers may be read and contributions to the discussions made in English, French, German or Italian; interpreters will be provided during the session. Papers from France, Great Britain, Ireland, Italy, Sweden, Switzerland, the United States and West Germany have already been promised. Notification of attendance must reach Prof. L. W. Pollak, at the Dublin Institute for Advanced Studies, before April 10.

Announcements

H.R.H. THE DUKE OF EDINBURGH has been elected an honorary member of the Institution of Electrical Engineers.

DR. J. N. HUNT, senior lecturer in Guy's Hospital Medical School, has been appointed to the University of London readership in physiology tenable at that School.

MR. CECIL WARBURTON, entomologist, formerly of the School of Agriculture and the Molteno Institute, University of Cambridge, who celebrated his hundredth birthday last year (see *Nature*, February 13, 1954, p. 289), was one hundred and one on February 6.

THE fourth World Petroleum Congress will be held in Rome during June 6–15. Further information can be obtained from the General Secretariat, Via Tevere 20, Rome.

AN International Symposium on Electrical Discharges in Gases will be held in the Technical University, Delft, during April 25–30. Further information can be obtained from A. W. van Wagensveld, Mijnbouwplein 11, Delft, Netherlands.

AN international conference on "Non-destructive Testing of Materials" will be held in Brussels during May 23–28. Further information can be obtained from the Secretary, l'Association des Industriels de Belgique, 29 Avenue André-Drouart, Auderghem, Brussels.

THE sixteenth General Assembly of the Fédération Internationale Pharmaceutique will be held in London during September 19–23. Further information can be obtained from D. F. Lewis, Pharmaceutical Society of Great Britain, 17 Bloomsbury Square, London, W.C.1.

A SUMMER school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory at Cambridge during September 12–23. Further information can be obtained from G. F. Hickson, secretary of the Board of Extra-mural Studies, Stuart House, Cambridge.

As already announced, the Fourteenth International Congress of Pure and Applied Chemistry is being held in Zurich during July 21–27. Registration for attendance must close on February 15. Correspondence should be sent to the Secretary-General, XIVth International Congress of Pure and Applied Chemistry, Zurich 1.

THE BIOLOGICAL COUNCIL: A PROGRESS REPORT

By Dr. W. P. K. FINDLAY

TEN years have now passed since the first moves were made to bring into being an organization that would enable British scientific societies in the biological field to collaborate in matters of mutual concern, and it may be of interest to survey what has been achieved in this direction

Many biologists had felt for some time that the activities of the specialized societies to which they belonged remained largely unknown to other biologists who happened to belong to different societies or associations, although often the activities of these other societies were of direct interest to them.

On the initiative of the Biochemical Society, representatives of some eight other societies attended an informal meeting on September 22, 1944, and agreed that steps should be taken to establish a co-ordinating committee consisting of representatives of the biological societies Thus the Biological Council came into being in July 1945, and in November of the same year, at a meeting held under the chairmanship of Sir Henry Dale, its officers were appointed and a programme of activities suggested (*Nature*, 156, 713 , 1945)

One of the first tasks undertaken was the preparation of an annual calendar containing information about the affiliated societies and the dates of their meetings This has appeared in one form or another each year since then, and has proved of great value to secretaries, who have thereby been able to avoid undesirable clashes in the dates of meetings of societies having similar interests.

In response to a demand from a number of biologists, a scheme was established in 1947 by which reprints of the titles of papers in the tables of contents of a group of journals were circulated soon after publication This scheme ran quite successfully for a number of years , but it was discontinued in 1953 owing to an inadequate number of subscribers

At the time when the Council was formed it was agreed that it should not concern itself with any professional matters affecting biologists themselves or their careers A sharp cleavage of opinion was revealed at the early meetings when this subject was raised by certain delegates, and at that time it would have been fatal to the success of the Council if professional matters had figured on its agenda. However, in 1946 the Association of British Zoologists invited the Council to consider the need for an Institute of Biology, and the Institute officially came into being as an independent organization on January 5, 1950 (*Nature*, 165, 131 , 1950) It was, however, felt that some continuing form of association between the two bodies was desirable and would lead to economies in the running of the Council business , so, in 1951, the Council became an advisory scientific committee to the Institute, which undertook to carry out the routine secretarial work of the Council. This arrangement has since worked well and to the mutual advantage of both bodies Following this reconstitution of the Council in 1952, Dr W P. K Findlay was elected chairman, Prof. F. L. Warren honorary treasurer, and Dr. J. L. Cloudesley-Thompson honorary secretary In 1954, Prof C T Ingold became chairman.

Societies the membership of which approaches four figures often find that the amount of routine secretarial work becomes too much for honorary secretaries to handle, and recently several such societies affiliated to the Council have arranged for this work to be carried out by the staff of the Institute The provision of such secretarial assistance in a central office was one of the original objects of the Council, and it is hoped that it will be possible to develop these facilities still further.

Several meetings have been held of the editors of the principal biological journals (including some that were not connected with the societies affiliated to the Council) to discuss problems of common interest Among proposals that were submitted to the Council at an early date was one suggesting some form of conjoint publishing bureau that would hold stocks of reprints and distribute them to individuals. This received little support, and it was at once clear that societies regarded the complete independence of their journals as an exceedingly important principle However, a number of useful suggestions were put forward at these meetings, on which action was afterwards taken. For example, many editors observed how much time had to be spent correcting literature citations in the manuscripts submitted to their journals, because these did not conform to the abbreviations given in the "World List of Scientific Periodicals". It was therefore decided that a selected list of the abbreviations of the titles of the biological journals to which reference is most frequently made should be prepared Mr. R W. Marsh, editor of the *Annals of Applied Biology*, kindly undertook this task and, with the co-operation of the "World List" authorities, a list was prepared and published in 1949, a second edition following in 1954

In 1947 the Keeper of the Science Library sought the assistance of the Council in obtaining the consent of its associated societies to permit photocopying of copyright papers published in their journals In general, a favourable response was forthcoming, and permission to reproduce photographically articles in all but the current issues was willingly accorded by most of the societies involved.

The poor delivery of scientific papers by inexperienced speakers often seriously detracts from their interest to the audience, so that accounts of fundamentally interesting work frequently do not receive the attention which they merit. Some "Notes for Speakers" were therefore prepared by the Biological Council in order to assist speakers at scientific meetings in the same way as "Instructions to Contributors" are issued to guide authors contributing papers to scientific journals These "Notes", which were first published in the *Annals of Applied Biology* in 1954, are available to members of the Institute of Biology and to members of affiliated societies

An obvious duty of the Council is to promote joint discussions between societies and groups of biologists who are interested in similar problems in related fields. The Council welcomed an invitation in 1951 from the Fine Chemicals Group of the Society of Chemical Industry to co-ordinate symposia on drug action, and a committee, under the chairmanship of Sir Charles Harington, was set up for this purpose. A number of highly successful symposia on subjects such as "Anticholinesterases", "Chemotherapy of

Tuberculosis" and "Insecticides" have already been held

The Council has been consulted on a number of occasions regarding various aspects of the teaching of biology, such, for example, as the teaching of human biology in schools, and it was asked to nominate a representative to serve on a national board to consider the recruitment and training of laboratory technicians

Many other minor matters have been dealt with by the Council, but perhaps one of the most important incidental benefits which members have derived from attendance at its meetings has been the personal contact between the officers of various societies and associations

---

MEDICAL RESEARCH LABORATORY OF VOJVODINA, NOVI SAD, YUGOSLAVIA

By Dr P. SCHWARZ

Director

IN 1947 it was announced in these columns[1] that a Yugoslav State laboratory was to be founded in Novi Sad, with the task of dealing with problems of experimental biology and medicine. For certain administrative reasons the laboratory was transferred to Belgrade, and the director, Dr. P. Martinovitch, continued his research in the Boris Kidritch Institute of Nuclear Science, where there were convenient facilities for carrying out his work. The premises in Novi Sad and a part of the fittings and apparatus were taken over by a newly founded bacteriological and serological laboratory under my leadership, and the whole organization was named the Medical Research Laboratory of Vojvodina This new Laboratory has fixed research tasks, and its budget is financed by the State.

Novi Sad is a relatively small town of 86,000 inhabitants, but notwithstanding is the cultural and administrative centre of a rather large territory containing about eight hundred medical practitioners. The idea arose that scientific research work should not be the privilege of a fortunate few, exclusively employed for this purpose in well-equipped laboratories with undisturbed working possibilities, the ordinary medical practitioner often has a creative idea, and it was proposed that an organization should be established with the task of preserving creative ideas and not letting them fall into oblivion. The state of medical conditions in Yugoslavia makes it imperative that this help should be given so as to develop ideas which are in close touch with practical questions of health and sanitation

The Laboratory has therefore been created in two parts one is the bacteriological and serological laboratory already mentioned, with full-time workers who are allotted research tasks, and the other is the 'service laboratory', where part-time laboratory workers are employed, with the task of helping physicians who are working out their ideas in their spare time The management of the Laboratory investigates whether the idea is original, whether it has some relations to practical sanitary questions and whether the Laboratory is able, taking into account limitations of staff and finance, to help in carrying out the research In the service department of the Laboratory the following part-time workers are employed a pathologist, a bacteriologist, a hæmatologist, a biochemist, and a surgeon for carrying out operations on experimental animals Besides these, the Laboratory employs assistants for part-time work according to the necessity and nature of the work. The above-mentioned sections are in the process of being formed and are at present only very modestly equipped, among other things, it is very difficult to get hold of medical publications and the periodical literature It might be thought that, under such conditions, it is a mistake to undertake such a job and that it would be better to wait until matters improve. But to do so would be to risk losing ideas and losing the collaboration of ambitious young workers, and this would be an even greater mistake, so we have decided to work under the present conditions, even at the risk of publishing something in ignorance of the fact that the same work has been published elsewhere by others.

The Laboratory has proved to be an active organization, for since the time of its functioning in 1951 eight research workers have asked for help from its laboratory service and have worked on the following topics, publishing them in the Yugoslav medical press and also partly in foreign periodicals the mechanism of blood clot retraction[2], the determination of the value of the thrombocytes with regard to their function in blood clot retraction[3], the determination of the serum protein fractions with the aid of salting out with ammonium sulphate[4], the fractionation of beef heart extract[5], new methods of making serial dilutions with small gradations[6], new methods for adjusting colloidal gold solutions and carrying out the colloidal gold test[7], the nature of the process of fibrinolysis and the products of the decomposition of the fibrin[8], serum proteins in pregnant women[9], the estimation of blood plasma clotting and the relation of the calcium concentration to the first and the second phase of blood coagulation[10], the therapy of miscarriage with histamine[11], the finding of enhanced sensitivity of some *Salmonella* strains to bismuth and the prescription of a modification of the Wilson–Blair medium for the elimination of the inhibitory power of bismuth (balanced sulphite agar)[13], experimental hyperfolliculinemy in dogs[14], and experimental eclampsia in dogs[15] Nearly all the papers enumerated in refs. 2–15 are written in Yugoslavian, but a translation or detailed summary will gladly be sent if requested. Besides these published papers, the following research problems have been registered at the Laboratory and are still under investigation the disturbances of the antihæmorrhagic mechanism in dogs injured by X-rays, the nature of the *S* factor of blood clot retraction, contribution to the pathogenesis of eclampsia, the investigation of the effect of the liver on œstrogen metabolism, the changes arising in the antihæmorrhagic mechanism caused by folliculin, the effect of cation combinations of the sulphite-reducing micro-organism, experiments on the quantitative estimation of the accessory growth factor, the effect of artificial hibernation on the incubation of some virus diseases.

The full-time part of the Laboratory has worked out experimentally the possibility of preparing desiccated culture media and has prepared an extract for the Meinicke clarification test. As a result of these investigations, the Laboratory has prepared a rather good desiccated Wilson–Blair agar on a small scale and, in addition, has furnished most of the *M*-antigen used in Yugoslavia

I do not know whether such an organization exists elsewhere, and I should be very grateful for any relevant information If this form of a research organization is a new one, its existence could, in my opinion, be explained by the special conditions of medicine prevailing in Yugoslavia on one hand, by the great demand for medical aid, which means that medical practitioners are very much preoccupied by routine medical work, and, on the other, by their desire for extending their medical knowledge This overtime work has proved a great stimulus, and furthered their interest in their profession

[1] Martinovitch, P N, *Nature*, **160**, 476 (1947)

[2] Marinkov, S, *Acta Med Iugoslav* **5**, No 3, 297 (1951)

[3] Marinkov, S, *Med Pregled*, **11/12**, 80 (1951)

[4] Marinkov, S *Acta Med Iugoslav*, **6**, No 2/3, 267 (1952)

[5] Schwarz, P, Congr Microbiology, Rome (Sept 7, 1953)

[6] Schwarz, P, *Acta Med Iugoslav*, **7**, No 3, 247 (1953)

[7] Schwarz, P, *Med Pregled*, **2**, 125 (1953)

[8] Marinkov, S, and Timotijević, B *Med Pregled*, **1**, 1 (1953)

[9] Dekanić-Milošević, V, and Marinkov, S, *Acta Med Iugoslav*, **7**, No 3, 215 (1953)

[10] Marinkov, S, and Kostić, D, *Med Pregled*, **4**, 332 (1953)

[11] Dekanić, Dj, and Grunčić, M, Cong Gynecol Belgrade (1953)

[12] Ivić, M, *Munchener Med Wochenschr*, **15**, 398 (1954)

[13] Schwarz, P, *Higijena, Belgrade* (in the press)

[14] Dekanić-Milošević, V, and Marinkov, S, Comm libres Cong Int Gynécol, Geneva, 1954 (in the press)

[15] Dekanić-Milošević, V, and Marinkov, S, *Gynécol et Obstet* (in the press)

THE BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

RESEARCH PANEL MEETING

THE ninth meeting of the Research Panel of the British Gelatine and Glue Research Association was held on December 9. Mr S G Hudson (Messrs Richard Hodgson and Sons, Ltd) was in the chair Three papers were presented, each being concerned with a major item of the research programme of the Association

Dr. J. E Eastoe in his paper, "Gelatin as a Chemical Compound", described the stages which must be followed in elucidating the chemical structure of proteins These include elemental analysis, amino-acid analysis, determination of amino-acid sequence, and also those aspects of the configuration of the intact protein, apart from sequence, which are affected by hydrolytic conditions The second of the stages was the basis of the work which was being reported The experimental method used was the chromatographic technique of Moore and Stein, using the ion exchange resin 'Dowex 50'[1], carried out almost exactly in accord with the original paper. This enabled all but one of the amino-acids present in gelatin or collagen to be estimated by means of two chromatographic experiments, one using a ong column of resin, and a second run in which a short column was used for the estimation of the basic amino-acids These are not given accurately with the long column The remaining acid to be estimated, hydroxyproline, was determined by the colorimetric method of Neuman and Logan[2] in preference to carrying out a third chromatographic separation

The method of analysis has been applied to a selection of gelatins and collagens of mammalian origin, and is also being extended to fish materials The general conclusions were that the results as a whole showed very satisfactory agreement with the determinations, by a number of methods, for gelatin by Chibnall and co-workers[3,4], and for collagen[3-5], for which Bowes and Kenten had also carried out careful analyses. The results for the whole range of materials also agreed well with the microbiological determinations of Neuman[6] The differences between the results for all the mammalian gelatins and collagens studied, with the exception of the content of amide nitrogen, and the ratio ornithine/arginine, were generally so small that they might result from small quantities of impurities The two exceptions arise not from differences in the native tissues, but from the effect of manufacturing processes The differences between mammalian and fish collagens, particularly in regard to the hydroxy amino-acids, confirm previous results[6].

Dr. A W Kenchington in his paper, "Gelatin Derivatives and their Properties", said that he had attempted to modify in turn all the more important polar groups of the gelatin molecule The behaviour of methylated gelatins, in which the carboxyl groups have been esterified with methanol in the presence of hydrochloric acid, had already been reported[7] The amino-groups were acetylated using acetic anhydride in the presence of sodium acetate The comparison of the degree of substitution, estimated by acetyl determination, and by measurement of the number of unreacted amino-groups by the titration curve method[8], showed that at low degrees of substitution only the amino-groups had reacted At higher degrees of substitution there was evidence of acetylation of hydroxyl groups also

The number of guanidino-groups of gelatin was increased by means of the reaction between the amino-groups and *o*-methyl isourea Almost quantitative reaction was produced, as shown by the technique of Moore and Stein[9], the lysine and hydroxylysine residues becoming homoarginine and hydroxyhomoarginine respectively Removal of the guanidino-groups by means of alkaline hypobromite, although effective for this purpose, also caused some degradation of the polypeptide chain

Mr P R. Saunders, in a paper on "Degraded Gelatins their Properties and Structure", described the effect of degradation in solution brought about by heat, extremes of *p*H, ultrasonics, and hydrogen peroxide The physical properties of the degraded gelatins which were measured included viscosity in both concentrated and dilute solutions, and gel rigidity over a range of temperatures from 0° C to near the melting point It has been established by this work that degradation can both reduce the mean molecular weight of the gelatin and also destroy to a greater or less extent an intrinsic power of gelling This point has been verified by fractionation of the degraded gelatins according to molecular weight

A general discussion on the gelling of gelatin was opened by Mr. A G Ward, director of research of the Association A G WARD

[1] Moore, S, and Stein, W H, *J Biol Chem*, **192**, 663 (1951)

[2] Neuman, R E, and Logan, M A, *J Biol Chem*, **184**, 299 (1950)

[3] Chibnall, A C, *J Int Soc Leather Tr Chem*, **30**, 1 (1946)

[4] Tristram, G R, "The Proteins", Vol 1*A*, p 181 (Academic Press, New York, 1953)

[5] Bowes, J H, and Kenten, R H, *Biochem J*, **43**, 358 (1948)

[6] Neuman, R E, *Arch Biochem*, **24**, 289 (1949)

[7] Kenchington, A W, reported in Ward, A G, *Nature*, **171**, 1099 (1953)

[8] Kenchington, A W, and Ward, A G, *Biochem J*, **58**, 202 (1954)

[9] Eastoe, J E, and Kenchington, A W, *Nature*, **174**, 966 (1954)

STATISTICS OF WINDFALLS AND DISASTERS

AN admirable little book, on the "Statistical Theory of Extreme Values and Some Practical Applications"*, presented in a vigorous and attractive style by one who has contributed extensively to the subject, has been written by E J. Gumbel and published by the United States National Bureau of Standards in its Applied Mathematics Series Suppose we have n independent observations x_1, x_2, , x_n, with a common distribution-function

$$F(t) \equiv \text{prob}\,\{x \leqslant t\}$$

Then, if y_1, y_2, ., y_n are the same n observed numbers re-arranged in descending order of magnitude, the largest value y_1, the smallest value y_n and the range $y_1 - y_n$ are three new random variables the joint distribution of which will depend on the distribution-function F with which we started. It is usual in statistical problems to have to make simplifying assumptions about the initial distribution before progress is possible In the history of the theory of extreme values we see an interesting reversal of this general rule, the characteristic features of the theory as it exists to-day did not emerge until special assumptions about the initial distribution (for example, that it was 'normal') were abandoned and instead attention was concentrated on whole classes of initial distributions giving rise to a common asymptotic behaviour of the distribution of y_1 The work of Fréchet in 1927 and of Fisher and Tippett in the following year revealed three forms of asymptotic behaviour for the distribution of y_1, when n is large, each being associated with a different class of initial distributions The assignment of a distribution to the correct class depends on the behaviour of $F(x)$ for large positive x and so not on the features of the initial distribution which normally strike one as the most important For example, the negative-exponential distribution,

$$F(x) = 1 - \exp(-x) \quad (x \geqslant 0), \qquad (1)$$

and the 'normal' distribution,

$$F(x) = \frac{1}{\sqrt{(2\pi)}} \int_{-\infty}^{x} \exp(-\tfrac{1}{2}t^2)\, dt \; (-\infty < x < \infty), \qquad (2)$$

belong to the same class If we restrict attention to (1), we can easily obtain a selection of results illustrating the general theory

Let y be the largest value in a sample of size n, ($F(x)$ being given by (1)), and let $y = z + \log n$. Then

$$G(u) \equiv \text{prob}\,\{y \leqslant u\} = \text{prob}\,\{\text{all } x_i \leqslant u\} = [1 - \exp(-u)]^n,$$

and

$$H(v) = \text{prob}\,(z \leqslant v) = G(v + \log n) = \{1 - \frac{1}{n}\exp(-v)\}^n$$

$$\rightarrow \exp\{-\exp(-v)\} \text{ as } n \rightarrow \infty$$

Thus for the reduced largest value z we obtain the asymptotic distribution,

$$\exp[-\{z + \exp(-z)\}]\, dz \quad (-\infty < z < \infty), \qquad (3)$$

valid when n is large. The distribution (3) has zero mode, a mean of $\gamma = 0\ 577$ (Euler's constant) and a standard deviation of $\pi/\sqrt{6}$. Analogous results hold when the initial distribution is of the 'normal' form, it is only the method of reducing the variable which must be altered.

The fact that

$$E\,\{\text{largest value}\} \simeq 0\ 577 + \log n \qquad (4)$$

for the distribution (1) (other distributions in the same class giving rise to similar formulæ) explains an empirical law discovered by W. E. Fuller the size of the largest flood increases linearly with the logarithm of the period of observation.

This brings us to the applications It will be obvious how a careful use of the theory supplies a rational approach to the old problem of 'the rejection of outlying observations', but more interesting are the situations in which the extreme values are themselves the principal objects of study, instead of being merely awkward facts which one would like to ignore Two such situations will be mentioned here, they are selected from many A flood is defined in the present context as the largest daily discharge of a given river in a given year It is thus the largest value in a sample of size $n = 365$ (or 366) members The lack of independence between daily discharges may, to a first approximation, be allowed for by assuming the weekly floods to be independent, so that $n = 52$ The effect of seasonal variations is less obvious, but the use of distributions such as (3) to describe the observed annual floods of rivers like the Mississippi has proved very successful and has been found of great value in dam design. A second application of particular interest is one which is currently being made to the study of the breaking-strengths of materials. ("No chain is stronger than its weakest link") In general, this work should interest all those who are concerned with the application of this sort of statistics to such problems as the breakdown of capacitors, the breaking strength of yarn, extinction times for bacteria, gust velocities in thunderstorms, the vagaries of the climate (and the stock market) and the occurrence of centenarians

DAVID G KENDALL

---

* United States National Bureau of Standards, Applied Mathematics Series No 3 Statistical Theory of Extreme Values and Some Practical Applications—A Series of Lectures By E J Gumbel, with the assistance of Julius Lieblein Pp viii+51 (Washington D C Government Printing Office, 1954) 40 cents

---

INSTITUTE OF HIGH-SPEED MECHANICS, TÔHOKU UNIVERSITY

THE Institute of High-speed Mechanics, Tôhoku University, which was established in October 1943 under the directorship of Prof F Numachi, grew out of the Faculty of Engineering of the University, in which considerable achievements in the study of cavitation phenomena had already been attained The Institute consisted initially of two research branches dealing with cavitation phenomena, and with engines and instruments, respectively In January 1945 four additional branches were established, but at the end of the Second World War the branch dealing with thermal fluid-dynamics related

BOOKS OF DIVERSE INTEREST
FROM CLEAVER-HUME

Crime Detection

The Examination of Clues

SVENSSON and **WENDEL**'s handbook on all the technical methods now available to the police has a Foreword by Commander G HATHERILL, O B E, of the C I D, is probably unequalled in its field and has copious bibliographies and 154 very remarkable illustrations 380 pp 38*s* 6*d*

★

Statistics for Social Sciences

By **T. G. CONNOLLY**, Ph D (Lond), and **W. SLUCKIN**, B Sc Eng (Lond), B Sc (Lond), author of the recent Penguin, *Minds and Machines.* Modest, clear and widely useful, this introduction provides what is needed for a General B A or B Sc degree. 16*s*

Textbook of Genetics - Hovanitz

The recent text by the Professor at San Francisco keeps a nice balance between basic principles and recent ideas 412 pp , 266 illustrations and colour plate. 42*s* 6*d*

Protoplasm - Frey-Wyssling

The latest (3rd) edition of *Submicroscopic Morphology of Protoplasm* surveys the rich results of electron microscopy and other recent advances 388 pp 182 illustrations 55*s*

Petroleum Microbiology

Prof **E. BEERSTECHER**'s is the first account of a frontier-land of sciences, of great potential economic importance 352 pp, 75 illus 55*s*

★

See you get subscription rate on

Aromatics

ready next month

Rodd *Vol. IIIa*

Chemistry of Carbon Compounds

This "marvel of compression and clarity," as one reviewer wrote, reaches in March a stage which large groups of chemists have eagerly awaited Few reference books can ever have had such unanimous praise SIR ROBERT ROBINSON, O M , F R S , heads its Advisory Board of six British professors, and the Editor of the 9-volume set is DR E H RODD A few weeks remain in which to secure the pre-publication rate, £5 15s , which is some 15% lower than list price Consult your bookseller, or us

Synopses, and new 54 pp Catalogue from
CLEAVER-HUME PRESS, LTD.
London 31 Wright's Lane, Kensington, W 8

Smith's for Professional Books

Books on scientific, industrial, chemical, electrical, mechanical and other specialized subjects can be quickly supplied through your local Smith's shop or bookstall

Your copies of NATURE can be bound into attractive volumes, and all your stationery and printed matter supplied through our local branch

W. H. Smith & Son
for SPECIALIZED BOOKS
HEAD OFFICE STRAND HOUSE, LONDON, W C 2

LENDING LIBRARY

SCIENTIFIC, TECHNICAL, MEDICAL

Annual Subscription from 25s.

PROSPECTUS POST FREE ON REQUEST

THE LIBRARY CATALOGUE containing classified Index of Authors and Subjects, revised to December, 1949 Pp xii + 1152 To subscribers 17*s* 6*d* net To non-subscribers 35*s* net, postage 1*s* 3*d* Supplement 1950 to 1952 To subscribers 3*s* net, to non-subscribers 6*s* net, postage 6*d*

H. K. LEWIS & Co. Ltd.
136 GOWER STREET, LONDON, W C 1
Telephone EUSTON 4282 (7 lines) Established 1844

The SCIENTIFIC BOOK SUPPLY SERVICE
(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE: CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

Technical Books

Ready 17th Feb

THE MICROTOMIST'S FORMULARY AND GUIDE

by Peter Gray, Ph D , F R M S

Med 8vo 794 pages Illustrated 65*s* net

and

IRRIGATED SOILS

Their Fertility and Management

by D W. Thorne, Ph D , and H B. Peterson, Ph.D

Roy 8vo 2nd ed 392 pages Illustrated. 45*s*

Ready shortly

GRIGNARD REACTIONS OF NONMETALLIC SUBSTANCES

by M S Kharasch and Otto Reinmuth

Throughout the planning and execution of this work the authors have borne in mind the imperative that information must be easily and quickly accessible to the user who employs it primarily as a ready reference compendium

Roy 8vo 1384 pages About £7

and

ADVANCED ORGANIC CHEMISTRY

by E E Royals

A practically useful integration of descriptive fact and unifying theory for the advanced student, presented in such a manner that he may attain a mature grasp of the subject

Roy 8vo 948 pages About 63*s*

ACTIVE NETWORKS

by C V Rideout

This book is intended primarily for those who have studied the physics of vacuum tubes and related devices as well as the fundamentals of the theory of passive linear networks

Demy 8vo 485 pages 42*s* net

●

CONSTABLE & CO. LIMITED
10-12 ORANGE STREET, LONDON, W.C.2

AN INTRODUCTION TO THE

BIOLOGY OF YEASTS

By M INGRAM, M A , Ph D

This book describes what the yeasts are and what they do It begins with an introductory chapter describing the general nature of yeasts, and then deals with the simpler and the more complex metabolic processes A section is devoted to the process of growth and reproduction, and the book closes with an account of the behaviour of the yeast colony and its place in nature Illustrated with line drawings and photomicrographs 25/- net

PITMAN

Parker Street Kingsway London, W C 2

THE MAMMALIAN FETUS:

Physiological Aspects of Development

COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY

Volume XIX (1954), 226 + *xvi quarto pages, with numerous figures*

Authoritative reviews of research, evaluating present knowledge about the morphological, physiological, and biochemical factors affecting the development of the embryo, in particular the human embryo, presented in 26 papers and edited discussions

Previous volumes still available IX (1941) Genes and Chromosomes, XI (1946) Heredity and Variation in Microorganisms, XII (1947) Nucleic Acids and Nucleoproteins, XIII (1948) Biological Applications of Tracer Elements, XIV (1949) Amino Acids and Proteins, XV (1950) Origin and Evolution of Man, XVI (1951) Genes and Mutations, XVII (1952) The Neuron, XVIII (1953) Viruses

Prices Volumes IX–XV, $7, XVI–XIX, $8 Volumes IX, XV, XVI, and XVIII any two, $14, any three, $20, all four, $26 Postage extra domestic, 25 cents, foreign, 50 cents per volume

LONG ISLAND BIOLOGICAL ASSOCIATION
Cold Spring Harbor, New York, U.S.A.

MACMILLAN BOOKS

American Chemical Industry

WILLIAMS HAYNES

An exhaustive and scholarly work which considers in chronological order the interwoven technical, economic, social, political and other factors which have influenced the development of American industry. *Volume I* 1608–1910 *Volume II World War I Period Volume III World War I Period Continued Volume IV The Merger Era Volume V* 1930–1939 *Volume VI The Chemical Companies*
£5 12*s* 6*d* each £28 10*s* the set

Guide for Safety in the Chemical Laboratory

This book sets forth in detail recommended safety procedures for the storing, handling and use of chemicals in every form It is up to date in every way and covers, among other things, radioactive materials. It should be kept as a guide and ready reference wherever chemicals are used 32*s.*

Advanced Level Examples in Physics

R V JOHNS, M A , B Sc

Lecturer in Physics and Mathematics, City of Liverpool College of Technology

W. F WARE, B Sc , A.Inst P

Senior Physics Master, Cathays High School for Boys, Cardiff

This book of numerical examples is designed to supplement the theoretical and laboratory work of students preparing for examinations in Physics at the Advanced level of the General Certificate of Education and for Intermediate Degree examinations Some 1,000 examples have been arranged by topics and carefully graded in difficulty Contents are arranged under the headings Mechanics and Properties of Matter, Heat, Light, Sound, and Magnetism and Electricity 16*s*

Functions of a Complex Variable

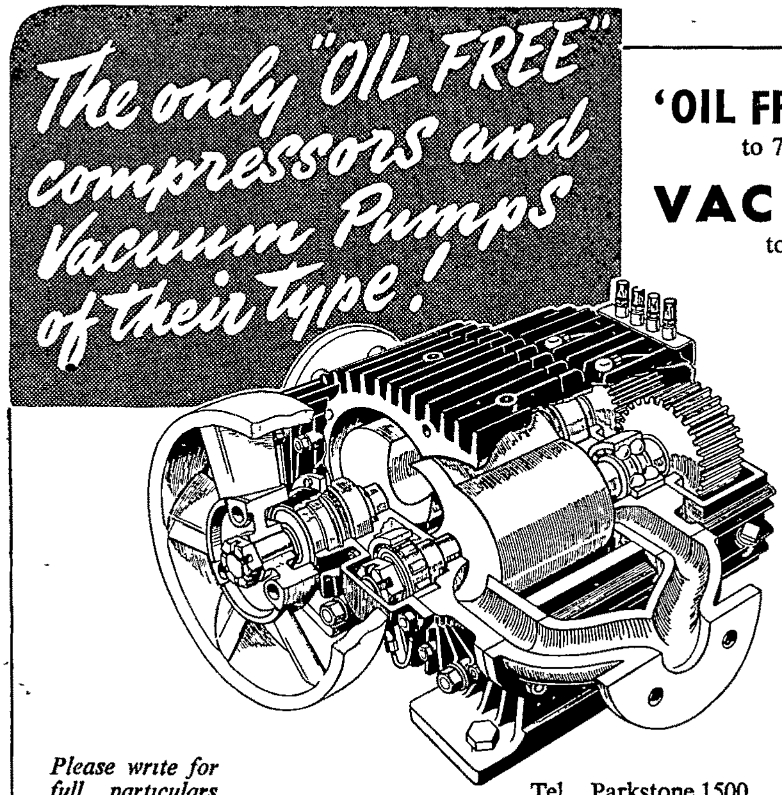
THOMAS M MACROBERT, M A., D Sc

Professor of Mathematics in the University of Glasgow

This book is designed for students who, having acquired a good working knowledge of the calculus, desire to become acquainted with the theory of functions of a complex variable, and with the principal applications of that theory In order to avoid making the subject too difficult for beginners, the author has abstained from the use of strictly arithmetical methods *Fourth Edition* 20*s*

All prices are net

St. Martin's Street, London, W.C.2


The only "OIL FREE" compressors and Vacuum Pumps of their type!

'OIL FREE' COMPRESSORS
to 70 lbs /sq. in. (5 kgs /cm ^{2})

VACUUM PUMPS
to within ½ mm. Hg Abs.

Air compressed and delivered free from oil or oil vapour.
No Sliding Vanes.
Air and Water-cooled models.
Fully comprehensive guarantee increased to 12 months.
Favourable deliveries
Reduced prices
First-class After Sales Service.

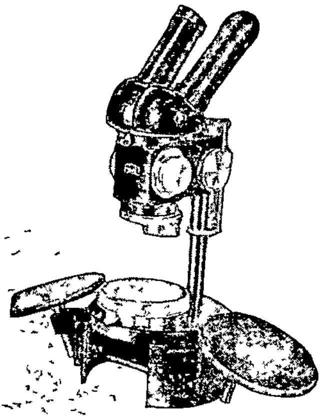
NORTHEY
ROTARY COMPRESSORS LTD
ALDER ROAD, PARKSTONE,
DORSET

Please write for full particulars

Tel. Parkstone 1500. Grams · Northey, Bournemouth

CARL ZEISS

STEREO MICROSCOPE



Rapid change of magnification in five steps from ×6 to ×40, ×12 to ×80, or ×24 to ×160 simply by turning a drum. The long working distance remains unchanged with change in magnification. Illustrated booklet from

DEGENHARDT & CO., LTD.
32 MADDOX STREET, LONDON, W 1
Mayfair 6639
Sole importers for Gt Britain and N Ireland

High-Speed CINEMATOGRAPHY

SIMPL LTD. offers a complete service in high-speed Cinematography at all speeds up to 3,000 pictures per second on 16 mm film.

SIMPL LIMITED, 1-4 LAMBETH HIGH ST, LONDON, S E 1

• Individually Tested and Guaranteed •
(A E R E Harwell approved)

HIGH VACUUM STOPCOCKS
New Catalogue on request to
G. SPRINGHAM & CO. Harlow New Town
"The Stopcock People" HARLOW 24108

OPTICAL FLATS & PROOF PLATES

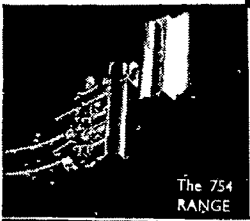
Your requirements may be listed in our Lens and Prism Leaflet but, if not, we would be glad to quote for making to specification

Our illustrated leaflets are available on request Listed are many Second-Hand and Ex-Government items of Photographic, Optical and Scientific interest

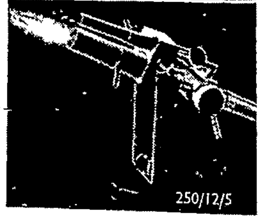
CHARLES FRANK
Instrument Makers and Dealers since 1907
67/73, SALTMARKET, GLASGOW, C.1
Phone Bell 2106 and 2107

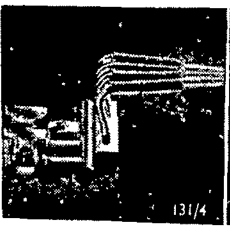
DO YOU PROCESS GLASS?

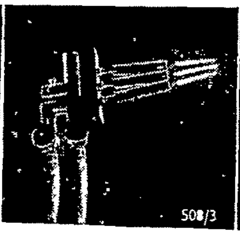
One of these **Bornkessel Burners** ***will make a better job of it.***

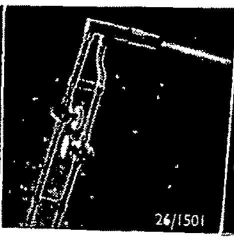


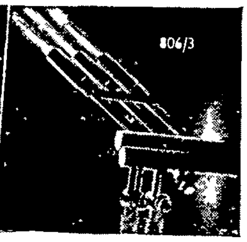
We designed them from our own experience of what's needed—and they are used in any number of factories producing chemical and industrial glassware.











For full details write to

STONE-CHANCE LIMITED ✻ Lighthouse Works, Smethwick 40, Birmingham.

✻ *The same people who make the "Flamemaster".*

THE MUSEUM BOOK STORE, LTD.
25 Devonshire St., London, W.1
(Welbeck 1340)
Buy and sell Scientific Journals and Periodicals and Learned Society Publications, in all languages. Librarians, and others, should send us their list of "wants", or duplicates for sale *Binding undertaken.*

Scientific Circulations Ltd.
We have extensive stocks of Technical Journals, Periodicals and Textbooks Special terms for Technical and Commercial Libraries All Scientific and Technical publications purchased
111, Eastbourne Mews, London, W.2
Telephone AMBassador 6934

WANTED TO PURCHASE

Scientific books & periodicals

Entire libraries, and smaller collections; sets and runs, foreign and domestic.

WALTER J. JOHNSON, INC.
125 East 23 Street, New York, 10, N.Y., U.S.A.
Cable Address BOOKJOHNS, NEW YORK
British Office: ACADEMIC BOOKS, LTD.
129 Queensway, London, W.2

THE PHYSICAL SOCIETY

1 Lowther Gardens, Prince Consort Road,
London, S.W.7.

●

The following Conference Reports will be published early in 1955.—

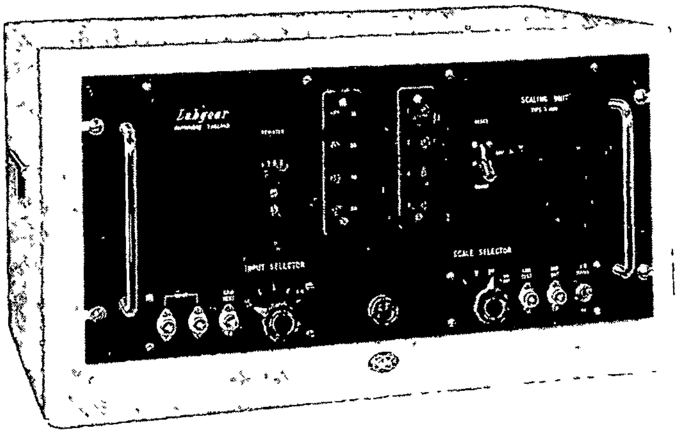
DEFECTS IN CRYSTALLINE SOLIDS
Conference held at the
H H. Wills Physical Laboratory
University of Bristol
in July, 1954

THE PHYSICS OF THE IONOSPHERE
Conference held at the
Cavendish Laboratory, Cambridge
in September, 1954

●

The price of each report will be £2
(25s to members of the Physical Society)

IT IS SELF-EVIDENT . . .



that there is more than mere convenience in selecting apparatus for a counting installation from a single supplier . . .

. particularly where he can offer an integrated family of units and ancillary equipment of proved effectiveness allied to economy in cost

THE SCALING UNIT type D4019 (the latest version of which is illustrated above) is competitively priced at **£98.0.0.** U.K. This versatile Labgear instrument, whose basic circuitry closely follows that of the successful A.E.R.E. type 200 design, thus forms a natural selection as the fundamental unit in a radioactive tracer installation and represents a typical example of this policy.

Please write for further details of E.H.T. Power Supplies, Regulated H.T. Power Supplies, Pulse Amplifiers, High Gain Amplifiers, Pre-Amplifiers, Discriminators, G M. Tube Mount and Sample Holders, Scintillation Counters, Electro-Deposition Cells, Micro-Hotplates, Interconnecting Leads and Rack Mounting Cabinets.

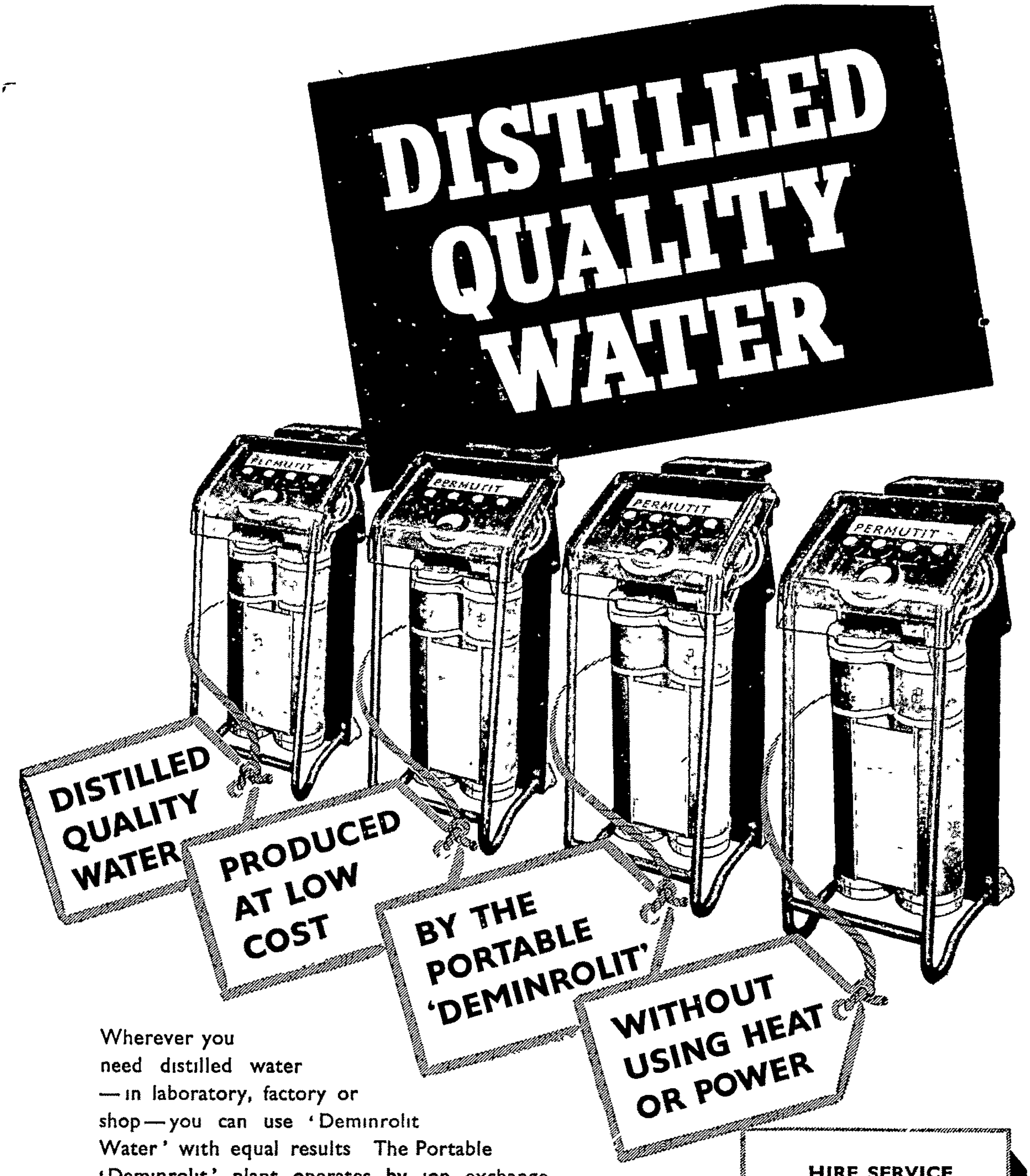
Immediate delivery of 1955 model Scalers, Power Supplies, etc.

Labgear (Cambridge) Ltd.

'grams :
Labgear Cambridge

WILLOW PLACE
CAMBRIDGE

'phone :
Cambridge 2494/5



Wherever you need distilled water — in laboratory, factory or shop — you can use 'Deminrolit Water' with equal results The Portable 'Deminrolit' plant operates by ion exchange and delivers water substantially free from dissolved solids. Running costs are measured in pence instead of in pounds, and you can thus use distilled quality water for many purposes where the cost of distillation would prove prohibitive

Please write for Technical Publication No 62 which gives full details.

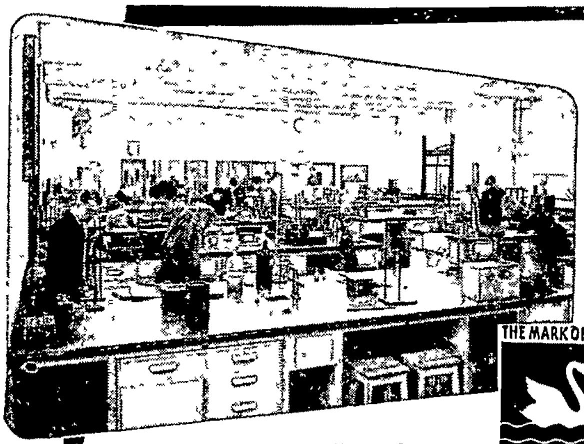
HIRE SERVICE

Why not try demineralised water in your industry? You can do so easily and cheaply by hiring from us, at a nominal rental for a trial period, the latest Mark II Model Portable 'Deminrolit' Plant Details of this service will gladly be supplied on request

PERMUTIT 'DEMINROLIT'

THE PERMUTIT COMPANY LIMITED

(Dept VH. 173), Permutit House, Gunnersbury Avenue, London, W.4. *Telephone · CHIswick 6431*



CYGNET

LABORATORY FURNITURE

"CYGNET" Benches, with heat and acid-resisting tops, Racks, Fume Cupboards, Cabinets and Shelving are made in a large range of standard units or to specification Complete installations or single pieces for Industrial, School and College Laboratories at keen prices Built to meet the most exacting demands

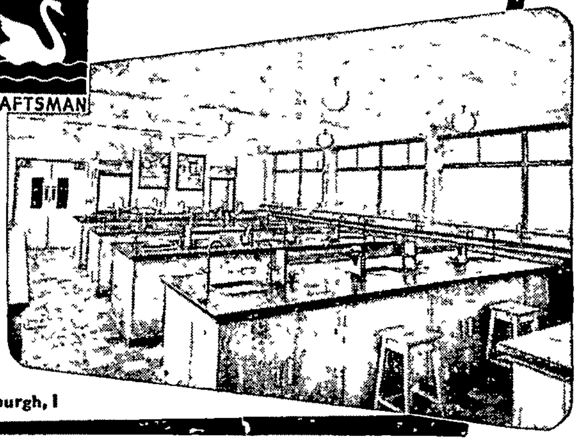
THE MARK OF THE CRAFTSMAN

Recent contracts include installations for —

Northern Ireland Hospital Authority, Belfast
University of Sheffield
British Nylon Spinners, Pontypool
Revertex Ltd , Harlow, Essex
De Havilland Aircraft Co
University of Manchester
Ferranti Limited, Edinburgh
Gt Lever School, Bolton

Experience enables us to recommend "FIBROLENE" chemical resistant flooring for laboratories Send for full details now.

CYGNET JOINERY LTD.
Higher Swan Lane, Bolton Bolton 1840/4
Scottish Agents·
Scottish Instrument Co , Ltd , 4-7 Teviot Place, Edinburgh, 1



C4

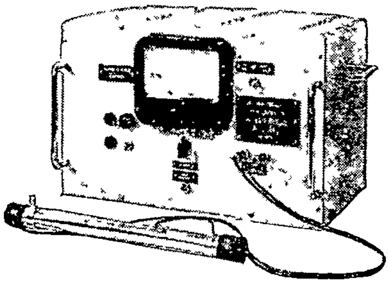
GRUBB PARSONS

A NEW INSTRUMENT

THE

SONIC GAS ANALYSER

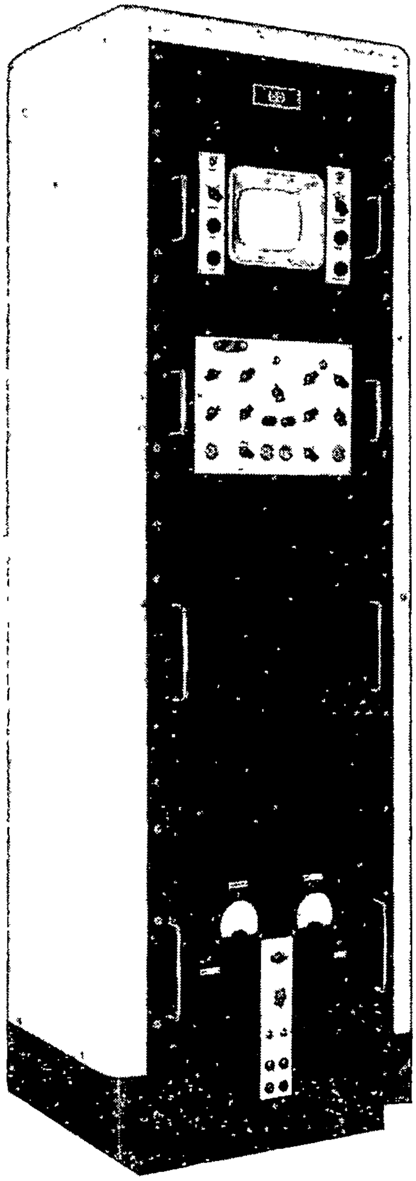
Enquiries Welcomed *Enquiries Welcomed*



This Instrument depends on the variation with composition of the velocity of sound in gases. Continuous analysis of many gas mixtures is possible Maximum sensitivity full scale for 1% by volume of one component. A typical application is the determination of the concentration of trichloroethylene vapour in air.

SIR HOWARD GRUBB, PARSONS & COMPANY
WALKER GATE, NEWCASTLE UPON TYNE, 6
PROPRIETORS: C. A. PARSONS & COMPANY LIMITED

PROGRESS IN CONTROL



SUNVIC
PULSE HEIGHT
ANALYSER

An instrument for the analysis of a complex pulse amplitude spectrum into groups of known height according to their voltage amplitude.

It displays up to a maximum of 120 channels and can store 1,200 binary digits. The design is based on that of Hutchinson & Scarrott (*Phil. Mag.*, 42, 792, 1951) and the instrument is made under licence from the N.R D C.

EQUIPMENT BY SUNVIC

SUNVIC CONTROLS LTD. *(Special Products Division), No. 1 Factory, Eastern Industrial Estate, Harlow, Essex.* Telephone Harlow 24231/5
Manufacturers of Pneumatic and Electrical Instruments for detection, measurement, control and recording of Temperature, Flow, Liquid Level, Specific Gravity and Pressure, in Science and Industry Vacuum Pumping and Measuring Equipment, etc
Member of the A.E I. Group of Companies.

TAS/Sc 305

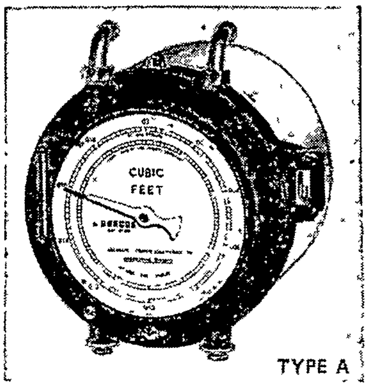
For accurate MEASUREMENT of small volumes of GASES

Type A Test Meter for the Laboratory

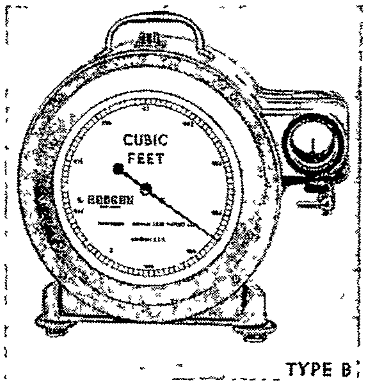
A Meter which sets up entirely new standards of accuracy in Engineering, Industrial and Medical Research

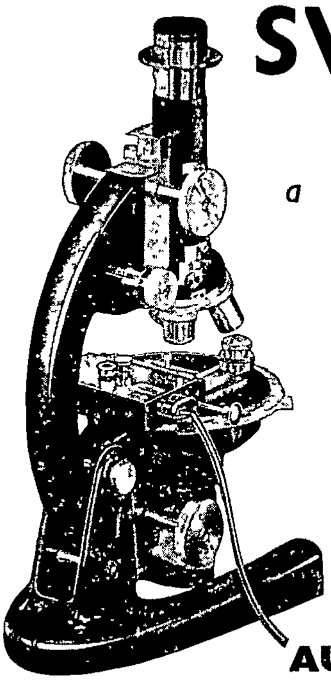
Type B Portable Test Meter

For normal Works tests, light weight, accurate, easily serviced and maintained



PARKINSON & COWAN INDUSTRIAL PRODUCTS
(A DIVISION OF PARKINSON & COWAN LTD)
ENGINEERING DEPARTMENT (2)
COTTAGE LANE WORKS, CITY RD., LONDON, E.C.1
Phone CLErkenwell 1766





SWIFT

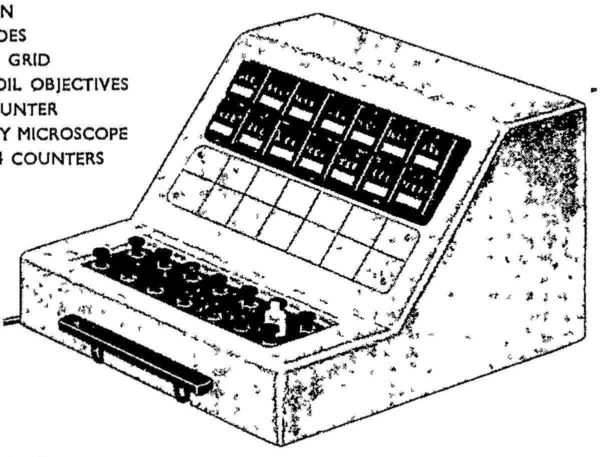
announce

a ***NEW ANALYTICAL TOOL***

for the

ANALYSIS BY POINT SAMPLING OF ANY MIXTURE WHOSE CONSTITUENTS ARE IDENTIFIABLE UNDER A MICROSCOPE

- ★ A C MAINS OPERATION
- ★ TAKES STANDARD SLIDES
- ★ CHOICE OF SAMPLING GRID
- ★ CAN BE USED WITH OIL OBJECTIVES
- ★ WITH TOTALISING COUNTER
- ★ CAN BE FITTED TO ANY MICROSCOPE
- ★ RECORDERS OF 7 & 14 COUNTERS



AUTOMATIC POINT COUNTER

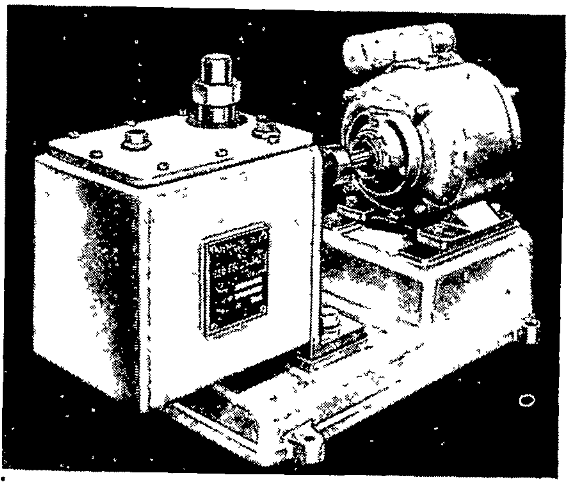
Brochure Free on Request

JAMES SWIFT & SON LTD.
113-115a CAMBERWELL ROAD, LONDON, S.E.5 RODNEY 544

Quiet Efficiency

METROVAC 2-STAGE ROTARY VACUUM PUMP

An oil-immersed, vane-type pump having a direct drive with integral gearing Pump and motor are mounted together on a cast-iron bedplate, and the drive is transmitted through a flexible coupling There is very little vibration or noise when the pump is running—an important consideration in many laboratories



Displacement *1 0 litre per sec*

Ultimate pressure as measured by McLeod gauge 0 0005 m m Hg

Normal speed of pump rotor *370 r p m*

- Quiet Operation
- Direct Drive
- Please write for leaflet 435/18-1

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

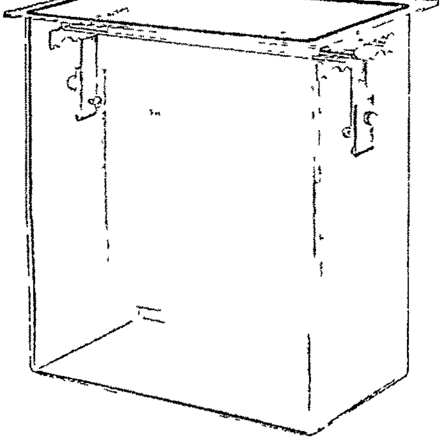
VACUUM PUMPS

N/P 401

SHANDON

CHROMATOGRAPHY and ELECTROPHORESIS EQUIPMENT

New 20 in two-way all-glass chromatank



Keeping in step with progress in the now widely used chromatographic and electrophoresis techniques, we are continually adding new items of equipment to our ranges of apparatus and accessories. We are *the* centre for all equipment for both techniques. Full particulars of any of the apparatus listed below will gladly be supplied on request.

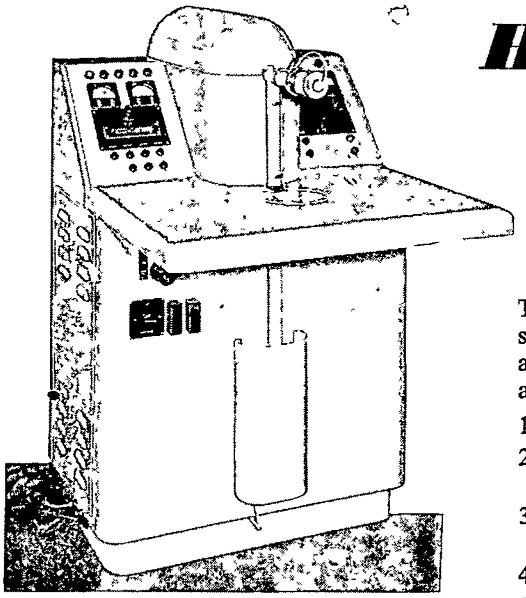
CHROMATOGRAPHY

Automatic Fraction Collectors Cabinets and All-Glass Tanks for one- and two-dimensional chromatography, including multi-sheet frame tanks Electrolytic Desalting Apparatus Chromatography Drying Ovens Amino Acid Standard Solutions Fluorescence Lamps Whatman Filter Papers Solvent Troughs Micro Pipettes Glass Sprays Paper Clips

ELECTROPHORESIS

Vertical and Horizontal Paper Electrophoresis Tanks with platinum coated electrodes Three types of D C Power Packs for output voltages of max 110, 250 and 1,000 volts, the latter with electronic stabiliser Continuous Electrophoresis Apparatus Densitometer for quantitative Paper Electrophoresis Planimeters Antweiler Micro Electrophoresis Apparatus

SHANDON SCIENTIFIC CO., LTD., 6 CROMWELL PLACE, LONDON, S.W.7. *Tel* *KNI* 1131



Hilger Micro-focus X-ray Unit

Incorporating the Ehrenberg & Spear Tube

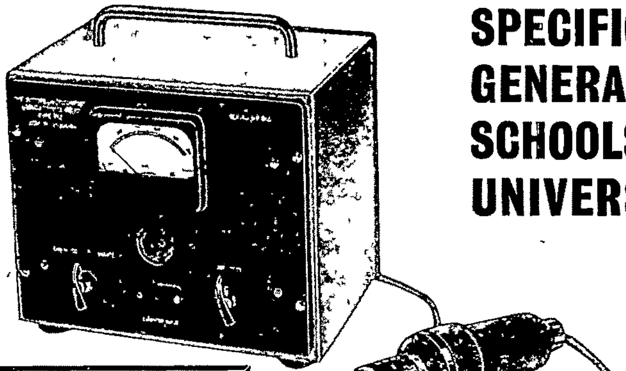
The Micro-focus Unit, with its small but extremely intense source spot, is primarily designed for diffraction work. it may also be used for micro-radiography Among its many advantages are

1) Reduced exposure times.
2) Direct X-ray magnification up to ten times, which may be supplemented by optical enlargement of the radiographs
3) Provision for use of vacuum cassette techniques for the examination of semi-transparent tissues
4) Exceptionally small focal spot (0 04 mm approx diameter)
5) Working potential between 5 and 50 kV ; tube supply is smoothed half wave
6) A range of easily interchangeable targets gives a wide choice of X-radiation
7) X-ray diffraction cameras for use with the unit are of smal diameter

Please write for Micro-focus catalogue CH 356 (*N*2) *and Cameras catalogue CH* 382 (*N*2)

HILGER & WATTS LTD
HILGER DIVISION
98 St. Pancras Way, Camden Rd.
London, N.W.1
England

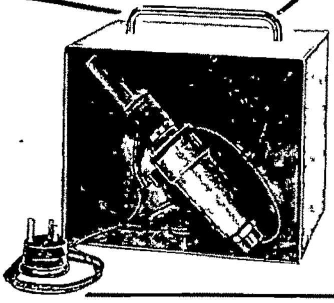
Member of the Scientific Instrument Manufacturers' Association and of SCIEX



SPECIFICALLY DESIGNED FOR GENERAL EDUCATION IN SCHOOLS, COLLEGES AND UNIVERSITIES

THE 'I D L.' RADIOACTIVITY METER is robust and simple to use and capable of making a wide range of measurements on beta and gamma rays Also suitable as an inexpensive general purpose laboratory monitor

Illustration shows how the probe fits into rear of unit for easy portability



- ***Trigger "flash" for low count rates and checking purposes.***
- ***Weston Meter Indication 0-50 counts/second.***
- ***Adjustable E.H.T. 300-600 volts indicated on meter, for plateau measurements.***
- ***Self-contained with probe and G.M. tube for beta and gamma counting.***

Full particulars from

ISOTOPE DEVELOPMENTS LTD

Laboratory and Works
BEENHAM GRANGE, ALDERMASTON WHARF
Nr READING, BERKS

London Sales Office
120 MOORGATE, LONDON, E C 2
Telephone METRopolitan 9641 *(5 lines)*

to aero-engines was closed down and the Institute now consists of five research branches with a senior scientific staff of five professors and five assistant professors

In the latest issue of the Reports of the Institute of High-speed Mechanics (5, No 41, 1954) a descriptive report of the historical development and of the present research activities is given, together with details of the personnel and government of the Institute. Most of the original buildings, with the exception of the workshop and underground water tank of the hydraulic laboratory, were destroyed during air raids, but reconstruction was commenced after the War and the main Institute building, together with a three-story reinforced concrete building with floor area of 10,670 sq ft and a connecting building of 2,670 sq. ft, have been erected These buildings house the heat, air, fatigue and vibration laboratories in addition to the administrative and workshop facilities.

The names of the various members of staff together with their subjects of research are listed in the report and details of the available research and workshop equipment are given The research topics are mainly concerned with cavitation tests on hydrofoil profiles, high-speed water turbines and axial flow pumps. Recent work on gas turbines is to be extended, and it is hoped to revive the research branch on thermal fluid-dynamics An impressive list of the titles of the scientific articles published by members of the staff of the Institute since 1949 and included in the report bears evidence of the steadily worthwhile results obtained both in the academic and applied fields of research at the Institute

S Weintroub

SOURCES OF GERMANIUM IN GREAT BRITAIN

By R. H. A CRAWLEY

Research Laboratories, British Thomson-Houston Co, Ltd, Rugby

GERMANIUM is an element of increasing interest, particularly for the manufacture of a variety of semiconductor devices by the electrical industry At the present time, germanium in Great Britain is obtained almost exclusively from gas-works flue dusts[1] Most British coals, except those from South Wales, contain small amounts of germanium[2], and we have therefore considered the possibility that useful concentrations of germanium might be found in the industrial plants of other large coal users

Samples from the British Electricity Authority The British Electricity Authority is the largest single user of coal in Britain. We believe that analyses have been made by other workers of deposits and flue dusts from various plants of the Authority, but few results have so far been published We have examined many samples of deposits and flue dusts and some typical results are shown in Table 1 The method of examination used was, with minor modifications, that described by Cluley[3]

It will be seen that a number of the superheater and economizer deposits show an appreciable concentration of germanium, but the flue dusts show only low concentrations The quantities of enriched deposits available vary widely from plant to plant, and, moreover, it is not always possible because of the structure of the plant to recover all the deposit potentially available Nevertheless, this source of germanium should repay further investigation.

Table 1 Germanium Content of Power Plant Residues

Source	Description	Germanium (per cent)
Northampton (East Midlands Division)	Economizer deposit	0 12
	Superheater deposit	0 05
	Deposit on last row of boiler tubes	0 14
Spondon (East Midlands Division)	Fly ash from bottom generator bank	0 014
	Bonded deposit from bottom generator bank	0 13
	Deposit on superheater tubes	0 09
	Deposit on upper generator bank	0 22
	Deposit on upper generator bank (different position)	0 28
	Deposit on economizer tubes (top)	0 14
	Deposit on economizer tubes (bottom)	0 05
Bolton (N W Division)	Deposit on bottom bank of generator tubes	0 025
	Deposit on bottom row of superheater tubes	0 09
	Economizer deposit	0 05
Trafford Park (N W Division)	Generator deposit	0 03
	Economizer deposit	0 06
	Superheater deposit	0 065
Halifax (Yorkshire Division)	Flue dust at chimney base	0 012
	Flue dust—air heater hoppers	0 005
	I D fan grit collectors	0 005
Bradford (Yorkshire Division)	Cyclone grits	nil
	Economizer grits	0 005

Gas Works Tar Although the largest concentration of germanium in gas works is found in the flue deposits of the producer-gas plant, we thought it worth while to examine the possibility of recovering germanium from tar or liquor, particularly in view of a report from Japan that a process has been developed there for recovering germanium from gas-works liquor With the co-operation of the Midland Tar Distillers, we examined a sample of tar which was representative of tar obtained from a number of gas works in the Midlands, it was found to contain 3–4 parts per million of germanium Also with the co-operation of the Midland Tar Distillers, we have examined the source of the germanium during tar distillation, with the results shown in Table 2. The method of examination again follows that described by Cluley, except that the tar is first ignited at 450° in air to remove the bulk of the organic matter If 450° is not exceeded, it has been shown that no germanium is lost by volatilization

It is evident that the germanium is entirely retained in the pitch fraction. Now the pitch normally contains about 0 2–0 5 per cent of ash, so that taking a figure of 10 parts per million of germanium in the pitch and assuming that all this would be retained in the ash, one might expect a germanium content in the ash of about 0 2–0 5 per cent.

A considerable quantity of pitch is burned as fuel, and we have therefore examined several flue dusts from a number of pitch-burning plants Typical

Table 2 Tar Distillation Distribution of Germanium

Crude tar, before distillation		3 4 p p m
Distillate fraction No 1	Up to 210° C	Nil
No 2	210°–250° C	Nil
No 3	250°–300° C	Nil
No 4	300°–350° C (approx)	Nil
Pitch Sample No 1 (continuous distillation)		11 5 p p m
No 2 ,, ,,		7 8 p p m
No 3 (pot still pitch)		6 4 p p m
Residue in pre-flash column		Nil
Residue at base of fractionating column		Nil

Table 3. GERMANIUM CONTENTS FOR RESIDUES FROM PITCH-BURNING PLANTS

The Midland Tar Distillers	
Flue dust from Babcock boiler	0.045 (high carbon content)
Firm using the Midland Tar Distillers fuel	
Flue dust from pitch-creosote burning plant	0.15
Dorman Long	
Flue dust—back flue	0.28
,, front flue	0.24
Boiler flue dust	0.21
Economizer flue dust	0.10

results are shown in Table 3, and the germanium contents are of the order expected. It is evident that these dusts constitute a potentially valuable source of germanium.

Other Coal-using Industries. Steel works consume large quantities of coal, and in a private communication from Mr. C. C. Gegg, of Thomas Firth and John Brown, Ltd., useful concentrates of germanium (up to 0.4 per cent) have been reported in flue dusts. A smaller quantity of coal is burned in the glass industry, and in this case we have found germanium in quantities up to 0.3 per cent in the flue dusts. Unfortunately, it appears that the amount of germanium-rich dust available from the latter source is negligibly small.

Acknowledgment is due to the British Electricity Authority, the Midland Tar Distillers, Thomas Firth and John Brown, Ltd., and Dorman Long and Co., Ltd., for their co-operation in this investigation; to Mr. J. E. Stanworth and Mr. J. V. Hardwick for helpful discussion; and to Mr. L. J. Davies, director of research, British Thomson-Houston Co., Ltd., for permission to publish this communication.

[Sept. 24.

[1] Powell, A. R., Lever, F. M., and Walpole, R. E., *J. App. Chem.*, 1, 541 (1951). Morgan, G. T., and Davies, G. R., *J. Soc. Chem. Indust.*, 56, 717 (1937).

[2] Aubrey, K. V., *Fuel*, 31, 429 (1952).

[3] Cluley, H. J., *Analyst*, 76, 530 (1951).

[4] *Chem. Trade J.*, p. 98, Jan. 9, 1953.

NITRIFYING ORGANISMS IN GLASSHOUSE SOILS

By DR. R. KLEIN

Glasshouse Crops Research Institute, Cheshunt, Herts

IN the course of investigations on the problem of nitrification in steam-sterilized glasshouse soil, suggested by Dr. W. F. Bewley, director of the Experimental and Research Station, Cheshunt, it was considered necessary to study the activity of the nitrifying organisms in pure culture and the possibilities of their improvement in pure and mixed (crude) cultures before trying to reconstitute the association soil + nitrifiers. Since it was not possible to obtain pure cultures from sources in Britain or abroad, the isolation of these organisms had to be attempted as the first step in this work.

The preliminary work comprised among other experiments the separation of *Nitrosomonas* and *Nitrobacter*, the use of silica gel plates which can be prepared without the tedious process of dialysing, the inoculation of these plates by streaking (according to various writers silica plates cannot be inoculated by streaking because water oozes out into the streaks), the use of antibiotics for purification of the nitrifiers, and the maintenance of the pure and the crude cultures under mineral oil; it is not yet known whether the presence of other soil bacteria has an effect on the nitrification in the soil, and it might be necessary to use crude cultures for the above-mentioned reconstitution.

The present account is concerned with only one part of this work. Although Winogradsky[1] mentioned that Boullanger and Massol[2] tried various ammonium compounds instead of ammonium sulphate and found that ammonium borate gave good nitritation, he kept to the use of the sulphate in the medium for *Nitrosomonas*, and this medium has been used as a standard medium, sometimes with minor modifications, by all workers in this field. I had experienced the favourable effect of borates in microbiological work of a different type and was, therefore, interested to find out how the nitrifiers would react to them.

The cultures used were *Nitrosomonas* sp. and *Nitrobacter* sp. isolated from glasshouse soil, separated and partly purified. The first experiments of this kind were made with F_{16}, and subcultures in 1-in. boiling-tubes were used to save incubator space. These boiling-tubes were kept in wire baskets in a sloping position to reduce the depth and enlarge the surface of the liquid medium.

In the work with *Nitrosomonas*, ammonium sulphate in Winogradsky's medium was replaced by ammonium borate, keeping the nitrogen contents at about the same level. No attempt was made to determine the optimum amount of ammonium borate, and owing to the limited incubator space some experiments had to be carried out at 25° C. instead of 30° C. The different temperatures probably require different amounts of ammonium borate. The cultures were tested on spotting plates, with Nessler's reagent for ammonia and with Trommsdorf's reagent for nitrite.

The experiments were repeated several times, always with three different series of cultures, which apparently represented three different strains, and set up in duplicate. A typical example is shown in Table 1.

Table 1 shows clearly that, under the conditions of the experiment, the ammonia disappeared more rapidly and the nitrite was formed more quickly in the cultures with ammonium borate. Since only spot tests were used for examining the course of the nitritation and no quantitative determinations were made, it is not possible to say whether the whole of the ammonia was oxidized to nitrite. The colour tests give only a relative picture, and their evaluation depends on my personal impression. Yet from the numerous tests, I believe that the appearance and increase of the nitrite in the ammonium borate cultures were sometimes slower than the disappearance of the ammonia, that is, there is a much greater difference between sulphate and borate cultures as regards disappearance of ammonia than as regards appearance of nitrite. It is possible that the degree of contamination has an effect, and some organisms other than *Nitrosomonas* might use up part of the ammonia in the borate cultures more quickly than in the sulphate cultures. Whether this is the case can only be found out by comparison of the activities of *Nitrosomonas* in mixed cultures and in pure cultures.

It was probably the metabolic activity of the accompanying soil bacteria that caused the discrepancy in a series of experiments with soils from Littlehampton. Three soils were used: a field-soil (*L/FS*), a manured (*L/B*), and a manured and

Table 1 NITRITATION IN MEDIA CONTAINING AMMONIUM SULPHATE AND AMMONIUM BORATE, RESPECTIVELY, BY THREE STRAINS OF *Nitrosomonas* sp /F_{20}

Strain	Source of ammonia	2 days		4 days		5 days		6 days		7 days		11 days	
		NR	TR	NR	TR	NR	TR	NR	TR	NR	TR	NR	TR
C/A	sulphate	+++(+)	+(+)	++(+)	++(+)	++	+++	+	++++	+	5	–	6
	borate	+ –	++	+(+)	+++	∓	++++(+)	–	5½	–	6	–	6
C/B	sulphate	+++(+)	++	+++	++(+)	++	++(+)	+	++++(+)	+	5	–	6
	borate	++	++(+)	+	+++(+)	(+)	++++	(∓)	5	–	6	–	6
C/C	sulphate	+++(+)	+(+)	+++	++	++(+)	++	+	+++(+)	(+)	5	–	6
	borate	++	+++	+	++++	+	++++(+)	∓	5	(∓)	5½	–	6

The marking is the customary one (∓) indicates a trace of colouring, increased intensity is shown by the number of + and by figures respectively

NR, Nessler's reagent the strongest reaction of the medium before inoculation was marked ++++
TR, Trommsdorf's reagent a trace of nitrite is marked (∓), full nitritation is 6

fertilized (*L/D*) glasshouse soil The crude cultures were made with ammonium sulphate medium Then transfers F_1 were made into ammonium sulphate and ammonium borate media and afterwards from sulphate cultures F_1 into sulphate medium and from borate cultures F_1 into borate medium, the two series being continued without cross-transfers from one kind of medium into the other As regards disappearance of the ammonia, the picture was always the same. It decreased in all three series considerably more rapidly in the ammonium borate cultures Yet as regards the formation of nitrite, the cultures from the three soils behaved differently In the borate cultures of *L/FS*, the formation of nitrite was for some time insignificant, and was increased only when, after the disappearance of the ammonia, another dose of ammonium borate was added But the nitrite contents never reached the same level as in the other cultures This discrepancy might perhaps be overcome by altering the quantitative composition of the medium In the *L/B* cultures the formation of nitrite was slower in the borate cultures than in the sulphate cultures, but reached eventually the same peak Yet in the *L/D* cultures the formation of nitrite lagged behind in the borate cultures of F_1, but from F_2 onwards it was faster than in the sulphate cultures

Experiments with *Nitrobacter* cultures from glasshouse soil at Cheshunt showed that this organism is very susceptible to boron, whether given as boric acid or sodium borate It was therefore of interest to keep the *Nitrosomonas* cultures made from the Littlehampton soils, after the whole of the ammonia had been oxidized to nitrite, and to test them again after an interval The results were quite interesting. The F_1 cultures were tested after about a month. In the ammonium sulphate cultures, the nitrite had almost completely disappeared, and diphenylamine–sulphuric acid gave strong reactions for nitrate, a few days later there was no trace of nitrite to be found The transformation of the nitrite to nitrate had apparently commenced much earlier, the beginning, however, could not be dated, since there was a comparatively long interval between the two critical tests, the one when nitrites were at their peak and the other one when scarcely any nitrite was detectable The ammonium borate cultures, however, with the exception of the *L/FS* cultures, gave always strong nitrite reactions, and when the experiment was concluded—the cultures were then more than two months old—they still did not show any change

In the tests of F_2, long intervals were avoided and it was therefore possible to find that the oxidation of nitrite to nitrate in the sulphate cultures started very early. In the cultures of *L/D*, the nitrite had disappeared in less than three weeks from the inoculation date, in *L/FS* and *L/B* cultures it took a little longer But again the ammonium borate cultures, after complete nitritation, remained unchanged, and even after seven weeks there was no decrease in the nitrite contents. As in F_1, the *L/FS* cultures with ammonium borate were here an exception, too.

Some *L/B* cultures did not show any decrease of their nitrite contents, a sign that there was no *Nitrobacter* present. It can always happen that the transfer of a mixed *Nitrosomonas–Nitrobacter* culture into a *Nitrosomonas* medium results in a *Nitrobacter*-free culture when the latter organism is weak or present only in very small numbers. Usually, however, it takes a fair number of transfers to obtain *Nitrosomonas* cultures free from *Nitrobacter*. Meiklejohn[3] still found nitrate production in the twenty-fourth successive transfer. The replacement of ammonium sulphate by ammonium borate can be used not only to achieve speedier nitritation but also to rid the *Nitrosomonas* cultures of *Nitrobacter* at an early, perhaps even at the first, transfer.

Owing to the imminent move of the Experimental and Research Station to Littlehampton, this work will have to be discontinued for the time being, and a preliminary report of it will be published elsewhere [Nov 25

[1] Winogradsky, S, in Lafar, F, "Handbuch der Technischen Mykologie, 3, 132 (1904)

[2] Boullanger, E, and Massol, L, *Ann Inst Pasteur*, 17, 492 (1903), 18, 181 (1904)

[3] Meiklejohn, Jane, *J Gen Microbiol*, 4, 185 (1950)

POSITION AND REACTIVITY OF THE HISTIDINE RESIDUES IN CYTOCHROME *c*

By DR. E MARGOLIASH

Molteno Institute, University of Cambridge, and Department of Experimental Pathology, Hebrew University, Jerusalem

THE position of the histidine residues in the cytochrome c molecule has been of interest since Theorell and Åkesson[1] put forward the suggestion that the imidazole groups of two histidines are the groups co-ordinating with the iron atom of the cytochrome c hæm, in positions 5 and 6, thereby producing the hæmochromogen type of spectrum of the protein These authors used a beef heart cytochrome c preparation containing 0 43 per cent iron. Their evidence was that, of the three histidine residues in the molecule, only one had an imidazole group which could be titrated in the pH range 5·5–8·5[2], the other two being presumably co-ordinated with the hæm iron.

Paul[3] showed that, on treating beef heart cytochrome *c* with 1,2,4-fluorodinitrobenzene, only 0·47 out of the three histidines did not form dinitrophenyl derivatives, as calculated from determinations of free histidine after complete hydrolysis of the dinitrophenylprotein. The free histidine was determined using a bacterial decarboxylase which reacts with histidine only if the imidazole, α-amino and carboxyl groups are unsubstituted.

Following the purification of cytochrome *c* on columns of cation exchangers, preparations containing 0·465 per cent iron could be obtained[4,5]. With these preparations the reactivity of the histidines was re-investigated using the more direct fluorodinitrobenzene method developed by Sanger[6].

Oxidized cytochrome *c* was prepared by treating the protein in water with hydrogen peroxide, precipitating the oxidized material with ten volumes of acetone in the cold and taking it up at once in water. Histidine was determined by the Pauly reaction according to Macpherson[7], after elution from paper chromatograms developed with the butanol – formic acid solvent of Acher and Crocker[8]. Imidazole mono-dinitrophenylhistidine was synthesized according to directions kindly provided by Dr. F. Sanger. α-Acetylhistidine[9] was treated with fluorodinitrobenzene and the α-acetyl imidazole mono-dinitrophenylhistidine obtained was hydrolysed in boiling 20 per cent hydrochloric acid. The product recrystallized from acetic acid was colourless. It migrated on butanol – formic acid paper chromatograms as a well-defined spot with a faint preceding trail of material. When dry, the spot darkened gradually in the light over a period of 5–10 days. Since the imidazole ring is rather labile when substituted, it may be that in this synthetic product the ring had opened. However, since the synthetic imidazole dinitrophenylhistidine was chromatographically identical with that obtained from dinitrophenyl cytochrome *c*, it must be supposed that if the ring had opened in the synthetic material it had done so also during the procedure with the protein, thus not affecting the argument. On the other hand, since alkaline hydrolysis of the synthetic imidazole dinitrophenylhistidine yielded some free histidine showing a positive Pauly reaction[10], at least part of the original product had an intact imidazole ring. Imidazole dinitrophenylhistidine was estimated by titration with titanous chloride[11] after elution with 35 per cent acetic acid in water from butanol – formic acid chromatograms. The identity of the material obtained from dinitrophenyl cytochrome *c* was confirmed by hydrolysing it with concentrated ammonia solution in a sealed capillary tube, and identifying the free histidine produced both chromatographically and by the Pauly reaction according to Sanger and Tuppy[10].

α-Amino mono-dinitrophenylhistidine was identified as a reddish-yellow spot which gave a positive Pauly reaction and a negative ninhydrin test on butanol – formic acid paper chromatograms of hydrolysates of dinitrophenyl cytochrome *c*. On such chromatograms it had an R_F value of 0·09 as compared with 0·02 for free histidine, 0·16 for imidazole dinitrophenylhistidine and 0·63 for *bis*-dinitrophenylhistidine. Several attempts to synthesize α-dinitrophenylhistidine resulted only in mixtures containing approximately equal amounts of imidazole dinitrophenylhistidine and α-dinitrophenylhistidine. Therefore, the identity of the presumed α-dinitrophenylhistidine obtained from dinitrophenyl cytochrome *c* was confirmed indirectly. It could be shown that when the material corresponding to the presumed α-dinitrophenylhistidine on a butanol – formic acid chromatogram of a hydrolysate of dinitrophenyl cytochrome *c* was eluted and treated with an excess of fluorodinitrobenzene under the usual conditions, it was transformed into *bis*-dinitrophenylhistidine, which was identified both by paper and column chromatography as described below. α-Dinitrophenylhistidine was routinely estimated by titration with titanous chloride[11] after elution from butanol – formic acid chromatograms with 35 per cent acetic acid in water.

Bis-dinitrophenylhistidine was determined spectrophotometrically after separation from other dinitrophenyl derivatives present in the continuous ether extract of hydrolysates of dinitrophenyl cytochrome *c*, on an ammonia-activated kieselguhr column according to Mills[12]. Its concentration in this continuous ether extract could also be calculated from the optical density of the extract at four selected wave-lengths (240, 290, 320 and 350 mμ), taking into account the extinction at these wave-lengths of the only four compounds in the extract, namely, *bis*-dinitrophenylhistidine, dinitroaniline, dinitrophenol and traces of ε-amino mono-dinitrophenyllysine. The four equations with four unknowns obtained could be solved for the concentration of any one of the compounds desired. The identity of the *bis*-dinitrophenylhistidine was further verified on paper chromatograms developed with tertiary amyl alcohol saturated with phthalate buffer pH 6, according to Blackburn and Lowther[13].

All results were calculated as moles per mole of cytochrome *c* iron, as determined spectrophotometrically and also directly by the dipyridyl method according to Keilin and Hartree[14]. The results were corrected for the destruction of the dinitrophenyl amino-acids during hydrolysis in the presence of cytochrome *c*.

Using a chromatographic fraction I[5] of horse heart cytochrome *c* containing 0·465 per cent iron (native, fully enzymically active protein) and carrying out the reaction with fluorodinitrobenzene in 66 per cent ethanol[6] for relatively short periods, the histidines were recovered as follows: 1 mole of *bis*-dinitrophenylhistidine, 1 mole of imidazole dinitrophenylhistidine, and somewhat less than 2 moles of free histidine. Determinations of histidine following hydrolysis of the original preparation of cytochrome *c* confirmed that horse heart cytochrome *c* contains four moles of histidine per mole of iron, rather than the three moles found in the beef heart preparation[1]. When the reaction with fluorodinitrobenzene in 66 per cent ethanol was continued for relatively long periods, there was a gradual disappearance of one of the histidine residues, which had previously been recovered as free histidine. This residue could then be accounted for as α-dinitrophenylhistidine. The second histidine residue, which was usually recovered as free histidine, could not be made to react even after prolonged periods of contact with fluorodinitrobenzene in 66 per cent ethanol under the usual conditions. When oxidized cytochrome *c* was used, nearly 2 moles of *bis*-dinitrophenylhistidine, 1 mole of imidazole dinitrophenylhistidine,

Table 1

Cytochrome *c* preparation	Reaction with FDNB Medium	Time (hr)	Moles/mole of cytochrome *c* iron Histidine	Im DNP histidine	α-DNP histidine	*Bis*-DNP histidine	ε-DNP lysine
Fraction I	—	—	4.05	—	—	—	—
Dinitrophenyl fraction I	Water	4	1.88	1.00	0.11	0.81	13.8
Dinitrophenyl fraction II	66 per cent ethanol	1	1.69	0.90	0.38	1.13	21.1
Dinitrophenyl fraction II	66 per cent ethanol	6	0.97	1.09	0.99	1.08	19.6
Dinitrophenyl fraction II	66 per cent ethanol	24	0.96	1.01	0.91	0.93	20.0
Dinitrophenyl oxidized cytochrome *c*	66 per cent ethanol	24	1.01	0.92	0.26	1.86	16.7

1 mole of free histidine and very little α-dinitrophenylhistidine were recovered.

In conclusion, it can be stated that one histidine residue is a normal amino end-group of cytochrome *c*, another histidine has a normally reactive imidazole group, while the last two histidine residues have unreactive imidazole groups. One of the latter histidines has a slowly reacting α-amino group and an imidazole group which reacts only after the protein is oxidized. Thus it represents an amino end-group of the protein with an attached imidazole group, the latter being liberated only after a drastic treatment which, together with other effects, destroys the cytochrome *c* hæm. The second unreactive histidine could not be made to react at all under any of these conditions.

Ethanol in the same concentration and under the same conditions as usually used for the reaction of fluorodinitrobenzene with proteins was found to transform fraction I cytochrome *c* into a product which had the same chromatographic characteristics on columns of 'Amberlite *IRC*-50' as the fraction II present in preparations of horse heart cytochrome *c* (compare with ref. 5), and, like it, was spectroscopically identical with fraction I but enzymically inactive. This alcohol-modified cytochrome *c* will therefore be referred to as fraction II. When the reaction of fraction I cytochrome *c* with fluorodinitrobenzene was carried out in water, thus preventing the transformation into fraction II, the distribution of the histidines into the various dinitrophenyl derivatives was the same as that shown by the dinitrophenyl fraction II obtained from reactions with fluorodinitrobenzene in 66 per cent ethanol for short periods.

Fraction II, moreover, appears to be an 'unfolded' or 'denatured' form of the native fraction I, as evidenced by the fact that with fraction II nearly all the twenty-two lysine residues present in the cytochrome *c* molecule react with fluorodinitrobenzene, whereas only fourteen can bind this reagent when fraction I is maintained in its original form during the reaction. A typical series of results is given in Table 1.

These results are in good accord with those obtained by Theorell and Åkesson[1] and Paul[3] with beef heart cytochrome *c*. Since in horse heart cytochrome *c* there are two histidine residues the imidazole groups of which are unavailable for reaction with fluorodinitrobenzene both in the folded native protein (fraction I) and the spectroscopically identical but unfolded enzymically inactive molecule (fraction II)[5], these groups are presumably already occupied, and possibly co-ordinated with the hæm iron.

Paul's recovery of only 0.47 mole as free histidine out of the original 3 moles in beef heart cytochrome *c* treated for two hours with fluorodinitrobenzene in the presence of ethanol[3] probably indicates that the third histidine, which had only partially reacted with fluorodinitrobenzene, corresponds to the one in horse heart cytochrome *c* which has an unreactive imidazole group but a slowly reacting α-amino-group (see Table 1). If this analogy is correct, and we assume further that the second hæmochromogen-forming group in horse heart cytochrome *c* is not one of the other two histidines reacting with fluorodinitrobenzene, in beef heart cytochrome *c* the second hæmochromogen-forming group is therefore probably not a histidine. This conclusion is similar to that arrived at by Paul as a result of his titration experiments[3].

It should be further noted that the one mole of *bis*-dinitrophenylhistidine and the one mole of α-dinitrophenylhistidine were the only end-groups so far observed with the fluorodinitrobenzene technique, thus suggesting that the cytochrome *c* molecule is built up of two peptide chains. In contradistinction to this, Theorell and Åkesson[1] calculated that beef heart cytochrome *c* contains nine to ten free amino-groups; they took the difference between the number of groups taking part in the Van Slyke nitrous acid reaction and the number of lysine residues found by analysis. Unless there is a profound difference in the proteins of beef and horse heart cytochrome *c*, this discrepancy is even larger than the large differences commonly noted with other proteins between the number of amino end-groups actually determined, as by the fluorodinitrobenzene technique, and the number calculated from the difference between the total free amino-nitrogen and that of the lysine residues. In the case of cytochrome *c*, this difference may have been increased by acidic peptides and amino-acids containing no lysine, bound electrostatically to the strongly basic cytochrome *c* protein[1] in the electrophoretically purified preparations of Theorell and Åkesson. These preparations contained 0.43 per cent iron, whereas those used in the present work contained 0.465 per cent iron, corresponding to a difference in equivalent weight of slightly more than 1,000, or some eight amino-acids.

I am grateful to Dr. K. Bailey and Dr. F. Sanger for instruction in the use of the fluorodinitrobenzene technique, and for their constant help in this work.

[1] Theorell, H., and Åkesson, Å., *J. Amer. Chem. Soc.*, **63**, 1804 (1941).

[2] Wyman, J., *J. Biol. Chem.*, **127**, 1 (1939).

[3] Paul, K. G., *Acta Chem. Scand.*, **5**, 379 (1951).

[4] Paléus, S., and Neilands, J. B., *Acta Chem. Scand.*, **4**, 1024 (1950).

[5] Margoliash, E., *Biochem. J.*, **56**, 535 (1954).

[6] Sanger, F., *Biochem. J.*, **39**, 507 (1945).

[7] Macpherson, H. T., *Biochem. J.*, **36**, 59 (1942).

[8] Acher, R., and Crocker, C., *Biochim. Biophys. Acta*, **9**, 704 (1952).

[9] Bergmann, M., and Zervas, L., *Biochem. Z.*, **203**, 284 (1928).

[10] Sanger, F., and Tuppy, H., *Biochem. J.*, **49**, 463 (1951).

[11] Siggia, S., "Quantitative Organic Analysis via Functional Groups", 82 (J. Wiley and Sons, 1949).

[12] Mills, G. L., *Biochem. J.*, **50**, 707 (1952).

[13] Blackburn, S., and Lowther, A. G., *Biochem. J.*, **48**, 126 (1951).

[14] Keilin, D., and Hartree, E. F., *Biochem. J.*, **39**, 289 (1945).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Sun's Magnetic Field and Corpuscular Emission

A NEW instrument, the solar magnetograph[1], has been developed for measuring and recording weak photospheric magnetic fields. With it, more than 450 magnetograms showing the distribution, intensity and polarity of weak fields (greater than 0.3 gauss) on the sun have been obtained over a two-year period including the recent minimum of solar activity[2]. Most of the large-scale features of the magnetic pattern show a certain regularity, but there are pronounced random variations. There is also a partially resolved fluctuating fine structure showing changes of the order of 0.5 gauss in 30 min.

General Magnetic Field. Consistent evidence has been found for a dipolar component opposite in polarity to the field of the earth. The mean intensity near the poles is of the order of 1 gauss. This field is usually limited to heliographic latitudes greater than about ± 55°; it has a varying fine structure and shows remarkable random fluctuations in effective intensity and extent. There seems to be no prevailing obliquity between the magnetic and rotational axes. The total flux is estimated to be nearly 10^{22} maxwells.

Bipolar Magnetic Regions. In the lower latitudes the stronger magnetic effects appear rather abruptly as contiguous areas of opposite polarity, as if loops of a submerged toroidal field were occasionally brought to the surface[3]. The bipolar magnetic regions obey Hale's laws of sunspot polarity[4], but spots are comparatively rare, occurring when at all within such regions while they are young and active. Ca II *plages* are observed where the mean field intensity is greater than about 2 gauss. Hydrogen filaments occur around the borders of bipolar magnetic regions, or, alternatively, seem to divide the region into parts of opposite polarity. As the regions age, they generally expand, showing a decrease in field intensity, and disintegrate until lost in the background of irregular weak fields. There is much diversity in total magnetic flux, duration, area, and course of development.

Unipolar Magnetic Regions. Occasional extended areas of only one outstanding polarity were recognized on the magnetograms, but in no other way. The most prominent unipolar magnetic region of 1953 had a mean intensity of about 0.5 gauss and a duration of nine months or more; on each solar rotation its central passage on the disk preceded by about three days the onset of terrestrial magnetic storms in a prominent 27-day sequence. Unipolar magnetic regions may be remnants of disintegrating bipolar magnetic regions from which the lines of force have diffused outward through the corona. We suggest tentatively that unipolar magnetic regions may be identified with the hitherto hypothetical M regions of Bartels[5].

The observations provide objective evidence that magnetic fields are fundamental to sunspots, *plages*, prominences, chromospheric fine structure, bright coronal emissions, regions of strong radio emission and, perhaps, M regions. Several solar phenomena can be synthesized on the hypothesis that neutral streams of ions and electrons are being ejected more or less continually from all turbulent regions of the surface characterized by coherent magnetic fields of mean intensity 0.5 gauss or more. This corpuscular ejection is supposed to be associated with spicule activity, and to result in the acceleration of tenuous streams, individually intermittent, to velocities of some hundreds of kilometres a second in the upper chromosphere and the corona. Above the photosphere the ejected streams are guided by the magnetic lines of force over the bipolar, unipolar, or polar region, as the case may be. The streams above the spicules are composed largely of ionized hydrogen and hence are invisible except in so far as they excite the coronal radiations of the arches, rays and plumes outlining the lines of force. Corpuscular streams ascending both sides of the 'magnetic arches' above a bipolar magnetic region collide near the top, generating radio noise[6], and condense, forming visible prominences. With the emission of radio energy the material cools, the hydrogen becomes partly neutral, and the prominence begins a possibly lengthy but precarious existence under the combined influence of growth, gravity and magnetic forces. Finally, the material largely slides back down the magnetic lines of force or may be thrown outward by expansion of the arches. Above unipolar regions the streams move outward diffusely and more or less radially from the sun[7], without pronounced collisions, and hence are not generators of strong radio noise; if they interfere with the earth, they cause M-region phenomena. From the polar regions, where spicule activity is pronounced, corpuscular streams may recede to considerable distances. Much of the material may arrive in the vicinity of the equatorial plane, where the magnetic field is doubtless highly irregular. Through magnetic coupling, such material may carry away from high heliographic latitudes a share of angular momentum that is large in proportion to its mass.

A tentative model for corpuscular ejection involves local concentrations of the coherent magnetic field by random turbulent processes in the photosphere. Occasional attainment of equipartition of energy results in formation of concentric tubes of magnetic force of intensity ~ 500 gauss. Travelling hydromagnetic waves in the form of constrictions in the tubes of force are supposed to move upward with velocity $H/\sqrt{4\pi\rho}$. Owing to the decrease of density, ρ, by a factor 10^6 in less than 10,000 km., velocities of several hundred kilometres a second may be expected in the high chromosphere if H decreases moderately. Small tenuous clouds of ions and electrons are supposed to be squeezed up the magnetic tubes ahead of the constrictions at the wave velocity. H. Alfvén[8] has considered heating of the corona by hydromagnetic waves; we extend this idea with the concept of constrictive waves in magnetic tubes of force.

HORACE W. BABCOCK
HAROLD D. BABCOCK

Mount Wilson and Palomar Observatories,
Carnegie Institution of Washington, and
California Institute of Technology

Nov. 23

---

[1] Babcock, H. W., *Astrophys. J.*, **118**, 387 (1953).

[2] Babcock, H. W., and Babcock, H. D., *Astrophys. J.* (in the press).

[3] Cowling, T. G., "The Sun", 568 (Kuiper, edit., Univ. of Chicago Press, 1953).

[4] Hale, Ellerman, Nicholson, and Joy, *Astrophys. J.*, **49**, 153 (1919).

[5] Bartels, J., *Terr. Mag. Atm. Elec.*, **37**, 48 (1932).

[6] Minkowski and Greenstein, *Astrophys. J.*, **119**, 238 (1954).

[7] Chapman and Ferraro, *Nature*, **126**, 129 (1930).

[8] *Mon. Not. Roy. Astro. Soc.*, **107**, 211 (1947).

Non-Linear Plasma Oscillations and Bursts of Solar Radio Emission

WILD and co-workers[1] have reported observing a fundamental and its second harmonic in the radio spectrum of some solar disturbances. Three characteristic features of the observations are: (i) the frequency bands drift towards the lower frequencies with time, (ii) the received intensities of the fundamental and second harmonic are similar, (iii) the harmonic peak usually occurs at slightly less than twice the frequency of the fundamental peak.

Because of their frequency drift, these bursts of radiation have been associated with the outward travel of streams of particles in the solar atmosphere. Inferred velocities range from several hundred to 10^5 km./sec. Such streams of particles could supply the energy of the most intense radio disturbances.

The observed intensity and frequency ratios have been explained by Wild *et al.* in terms of propagation characteristics of the solar atmosphere. In doing so it was found necessary to assume that the fundamental emission occurs at, or near, the plasma frequency. This points strongly to the origin of the radiation in plasma oscillations. The presence of the second harmonic implies a non-linear oscillator and suggests longitudinal plasma oscillations.

It is the purpose of this communication to show that exact travelling-wave solutions, rich in even harmonics, can be obtained for non-linear plasma oscillations.

The case investigated here is that of longitudinal electron oscillations in a plasma stream. Effects of temperature and magnetic field are neglected.

Let v and n be the electron velocity and density, v_0 and n_0 those of the positive ions in the plasma, E the electric field, ω the angular wave frequency, and ω_0 the angular plasma frequency given by $\omega_0^2 = 4\pi e^2 n_0/m$, $-e$ and m being the electron charge and mass. If the two independent variables, t and x, occur only in the combination $\omega t - kx$, the equations describing the plasma are (in e.s.u.)

equation of motion $$v'(\omega - kv) = -\frac{e}{m}E, \qquad (1)$$

equation of continuity $$n'(\omega - kv) - knv' = 0, \qquad (2)$$

and Poisson's equation $$n - n_0 = \frac{k}{4\pi e}E' \qquad (3)$$

The prime denotes differentiation with respect to $\omega t - kx$.

Similar equations have been solved by Akhiezer and Lubarskii[2], but their solutions do not seem to satisfy Poisson's equation.

Write $$u = v - v_0. \qquad (4)$$

Assuming that the electron d.c. current density equals that of the positive ions, $n_0 e v_0$, an exact set of solutions of equations (1)–(3) are

$$\omega = \omega_0 + kv_0, \qquad (5)$$

$$\omega t - kx = (l+\tfrac{1}{2})\pi + (-1)^l \frac{u_{\max}}{\omega_0/k}\sqrt{1-(u/u_{\max})^2} + (-1)^l \sin^{-1}(u/u_{\max}), \qquad (6)$$

where $l = 0, \pm 2, \pm 4, \ldots$ applies where u' is positive, and $l = \pm 1, \pm 3, \pm 5, \ldots$ where u' is negative. The origin, $\omega t - kx = 0$, has been placed at $l = 0$, $u/u_{\max} = -1$.

The electron density and electric field are given in terms of the electron velocity by:

$$\frac{n}{n_0} = \frac{1}{1 - \dfrac{u}{\omega_0/k}} \qquad (7)$$

and

$$\frac{E}{E_{\max}} = (-1)^{(l+1)} \frac{u_{\max}}{\omega_0/k}\sqrt{1 - (u/u_{\max})^2} \qquad (8)$$

where

$$E_{\max} = \frac{m\omega_0^2}{ek}. \qquad (9)$$

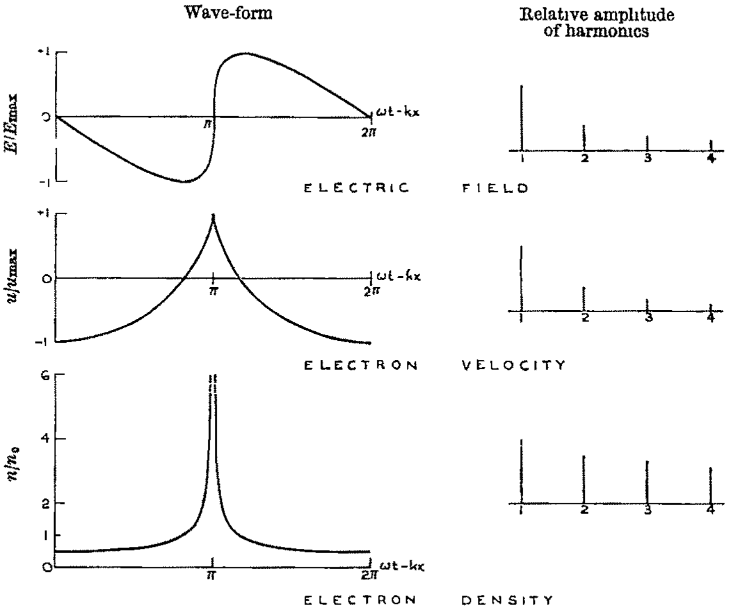


Fig. 1. Longitudinal plasma oscillations. The maximum electron velocity equals the phase velocity

The oscillations reach their greatest amplitude where $u_{\max} = \omega_0/k$, that is, where the maximum electron velocity, $v_{\max}$, equals the phase velocity, ω/k. The wave-form and harmonic content of the oscillations for this case are illustrated in Fig. 1. As can be seen, the oscillations contain even and odd harmonics, with about 70 per cent second harmonic in the case of the electron density. Below maximum amplitude the harmonic content is weaker and approaches the linear case (fundamental only) for small amplitudes.

If large oscillations of this kind are responsible for the emission of solar radio bursts, the present results would suggest that harmonics higher than the second may yet be discovered.

S. F. SMERD

Division of Radiophysics,
Commonwealth Scientific and
Industrial Research Organization,
Sydney.
Sept. 9.

---

[1] Wild, J. P., Murray, J. D., and Rowe, W. C., *Nature*, 172, 533 (1953). Wild, J. P., Roberts, J. A., and Murray, J. D., *Nature*, 173, 532 (1954). Wild, J. P., Murray, J. D., and Rowe, W. C., *Aust. J. Phys.* (in the press).

[2] Akhiezer, A. I., and Lubarskii, G. Y., *C.R. Acad. Sci., U.S.S.R.*, 80, 193 (1951).

Disintegration Scheme of Copper-62 and its Relation to Recent Mass Measurements

Several nuclear data tables[1,2] report the existence of a 0·56-MeV. γ-ray in the disintegration scheme of the positron-emitting isotope copper-62, the evidence advanced being an unpublished absorption measurement. We have lately had occasion to examine the spectrum of γ-rays emitted by copper-62, and have failed to find any evidence to confirm the existence of such a γ-ray.

A sheet of copper 3 in. × 4 in. × ½ in. was irradiated with X-rays from a 23-MeV. synchrotron. Copper-62 was produced by (γ,*n*) reactions. This source was then placed 2 cm. from the end of a large cylindrical sodium iodide crystal 1⅝ in. in diameter and 2 in. long, which was mounted on a DuMont type 6292 photomultiplier. This crystal was large enough for secondary quanta from Compton collisions and photoelectric absorption processes occurring in its interior to have an appreciable probability of being themselves absorbed. A copper absorber ⅛ in. thick was placed in front of the source to prevent positrons reaching the crystal. The output pulses were amplified and fed into a 100-channel amplitude analyser.

The resulting spectrum showed a single well-defined 'total capture' peak and Compton edge from the annihilation quanta superposed on the usual crystal background. The width of the peak at half-height was 14 per cent, that is, 0·066 MeV. No other peaks were observed in the channels corresponding to 0·6–1·2 MeV. We estimate, having regard to the background, that a peak containing 0·25 per cent of the counts in the total capture peak and of comparable width would have been detected.

The simultaneous absorption by the crystal of a 0·56-MeV. γ-ray and an annihilation quantum would have produced a 'coincidence' peak in the vicinity of 1 MeV. From the above upper limit to the detectable peak, and from the efficiency of crystal detection and solid angle subtended at the source, it follows that not more than 5 per cent of the positrons can be in coincidence with a 0·56-MeV. γ-ray.

Further, the absence of a peak in the observed spectrum in the range 0·6–1·2 MeV. means that there is no evidence for a γ-ray in the range 0·1–1·2 MeV., since γ-rays in the range 0·1–0·7 MeV. would have produced a 'coincidence' peak between 0·6 and 1·2 MeV.; while γ-rays of energy between 0·6 and 1·2 MeV. would have produced the usual total-capture peak in the range 0·6–1·2 MeV. The upper limit of intensity allowed by our observations for a γ-ray in coincidence with the positrons is 5 per cent of the total number of disintegrations. No evidence exists that there is a γ-ray of energy greater than 1·2 MeV., and we conclude that there is no γ-ray in coincidence with the positrons. The total release of energy in the copper-62 disintegration can therefore be obtained from the maximum energy of the positron spectrum[3,4] and is 3·88 ± 0·1 MeV.

The spectrum of copper-62 is important for two reasons. First, the production of this isotope by (γ,*n*) reactions is very commonly used in the monitoring of X-ray beams in the energy range 10–30 MeV. Absolute monitoring is best done by irradiating a thick specimen and detecting the annihilation quanta. The estimation of the activity requires a knowledge of whether or not there are γ-rays emitted.

Secondly, the value of the total energy released calculated above throws doubt on the accuracy claimed for some recent mass measurements. Using the mean of two accurately measured values of the ^{63}Cu(γ,*n*) threshold[5,6], namely, 10·67 MeV., we find that the (^{62}Ni + ^{1}H) − ^{63}Cu mass difference is 6·43 ± 0·12 m.m.u. This is significantly different from the value of 5·7 ± 0·1 m.m.u. obtained from the mass spectrometer measurements by Collins *et al.*[7] of the doublets ^{62}Ni − C$_5$H$_2$ and ^{63}Cu − C$_5$H$_3$. In the same region of the Periodic Table, the ^{64}Zn − ^{64}Ni doublet shows a similar discrepancy, the value obtained from the decay scheme of ^{64}Cu[2] being 1·18 ± 0·03 m.m.u. and that obtained by Collins *et al.* being 2·01 ± 0·08 m.m.u. In view of the second discrepancy, it is not justifiable to attempt to explain the first discrepancy on some basis such as the (γ,*n*) cross-section of copper-63 being negligible in an energy region immediately above the neutron-binding energy. Until these discrepancies are explained, it would appear that the mass measurements in this region should be used with caution.

J. M. Reid
I. F. Wright

Natural Philosophy Department,
University of Glasgow. Dec. 16.

---

[1] Hollander, J. M., Perlman, I., and Seaborg, G. T., *Rev. Mod. Phys.*, 25, 469 (1953).

[2] "Nuclear Data" (National Bureau of Standards, 1950).

[3] Hayward, R. W., *Phys. Rev.*, 79, 541 (1950).

[4] Becker, R. A., *et al.*, *Phys. Rev.*, 76, 1406 (1949).

[5] Birnbaum, M., *Phys. Rev.*, 93, 146 (1954).

[6] Katz, L. (private communication).

[7] Collins, T. L., Nier, A. O., and Johnson, W. H., *Phys. Rev.*, 86, 40 (1952).

Thermal Diffusion Potentials and the Sore Effect

In a recent communication[1], Tyrrell and Colledg have directed attention to the possibility of studyin the Soret effect in solutions of electrolytes by observations of the e.m.f. of non-isothermal cells. In suc cells, two reversible electrodes are maintained a different temperatures; owing to thermal diffusion the concentration of solute around one electrod increases and that around the other decreases. I consequence, an additional e.m.f. should graduall be set up, which, for small temperature differences, i simply the e.m.f. of an isothermal concentration ce (with transport) operating at the mean temperatur

During the past two years, we have succeeded i demonstrating and measuring such changes of e.m. in various aqueous solutions, using the followin electrodes, all of which give very reproducibl potentials: platinum/tri-iodide, iodide; cadmiu amalgam/cadmium ion; thallium amalgam/thallou ion. In our experiments, the temperature gradien has been established in sintered glass diaphragm which prevent convection but may possibly giv anomalous results in very dilute solutions owin to surface effects. Most of our observations hav therefore been made at concentrations of 0·1 mol and upwards, it being known[2] that the presence of sintered diaphragm does not affect the isotherm diffusion coefficients of 1–1 electrolytes in this concentration-range.

Experiments using the platinum/tri-iodide, iodid electrode in lithium iodide, potassium iodide an hydrogen iodide were carried out in a modifie diaphragm diffusion cell, fitted with magnetic stirrer and with water jackets, whereby the upper and lowe compartments could be maintained at different temperatures. Clear evidence of the expected effect w obtained; but the method was found unsuitable f quantitative work because it was not possible t maintain sufficiently isothermal conditions within each separate compartment even with vigorous stirring. For this reason a different technique, applicable to amalgam electrodes, was developed. The cell used is shown in Fig 1, the solution is entirely contained in the sintered glass diaphragm, and since its thickness is only about 0·15 cm, Soret equilibrium is established rapidly. Owing to the comparatively poor thermal conductivity of mercury, there are appreciable temperature differences between the thermocouples and the electrode/solution interfaces, of which the temperatures are required. It is therefore necessary to calibrate the temperature-measuring system by comparing the initial e.m.f. of this cell (that is, the e.m.f. when the solution is homogeneous) with the e.m.f. obtained using similar electrodes in a homogeneous solution in a different apparatus in which the temperature gradients in the amalgams are negligible.

Fig 2 shows some results obtained with thallium amalgam electrodes (5·0 per cent thallium by weight) in solutions containing thallous salts. A constant temperature difference of about 6 deg. C. was maintained between the electrodes from zero time onwards, the mean temperature being 25° C, the observed e.m.f.'s are converted to the 'thermo-electric power' (ε) in mV. per deg, with the sign convention that positive ε implies a flow of current from hot to cold in the external (metallic) circuit when the cell is short-circuited. The expected changes of e.m.f. are clearly apparent. Magnetic stirring of the upper amalgam did not produce any detectable change in the e.m.f., showing that the observed effects are not due to thermal diffusion in the amalgam.

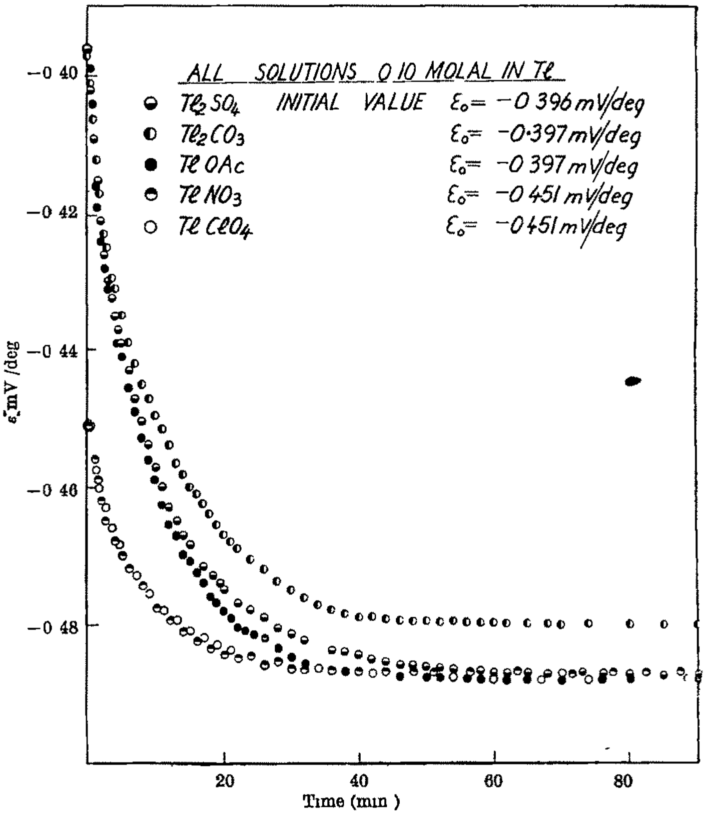


Fig 2

It has been shown theoretically[3] that, provided ionic interaction can be neglected, the final values of the e.m.f.'s of such cells should depend only on the nature and concentration of the ion to which the electrode is reversible, unlike the initial values, which depend also on the properties of the other ions present. It will be seen that this prediction is confirmed by the results, except in the case of thallous carbonate, the agreement of the final e.m.f.'s is surprisingly good in view of the comparatively high concentration used.

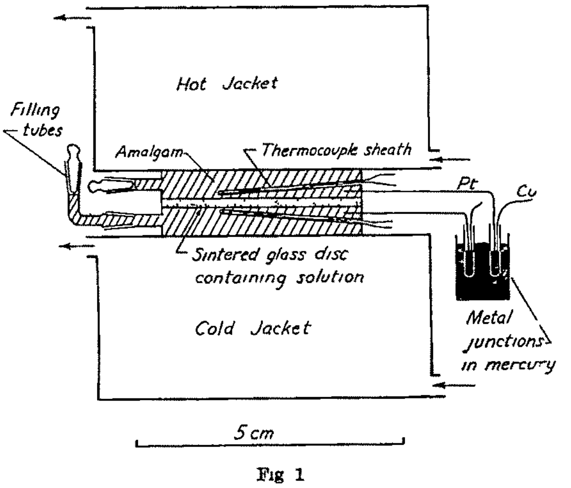


Fig 1

The dependence of e.m.f. on time for these solutions agrees well with the theoretical relationship, although the simplified approximate expression given by de Groot[4] does not adequately represent the observations. A more complicated dependence on time is involved if a mixture of two electrolytes (for example, 0·1 *m* thallous perchlorate + 0·1 *m* perchloric acid) is employed. In this particular case the e.m.f. actually passes through a maximum, the initial value ($\varepsilon_0 = -0{\cdot}662$ mV./deg.) is very low owing to the exceptionally large Soret coefficient of the hydrogen ion, but the final value ($\varepsilon_\infty = -0{\cdot}478$ mV./deg.) is close to that observed in other solutions containing thallium ion at concentration 0·1 *m*.

A fuller account of this work will appear elsewhere.

J. N. Agar
W. G. Breck

Department of Physical Chemistry,
Free School Lane, Cambridge. Oct. 7.

[1] Tyrrell, H. J. V., and Colledge, R., *Nature*, **173**, 264 (1954).

[2] Stokes, R. H., *J. Amer. Chem. Soc.*, **72**, 763 (1950).

[3] Haase, R., *Trans. Farad. Soc.*, **49**, 724 (1953). Khoroshin, A. V., and Temkin, M. I., *Zhur. Fiz. Khim.*, **26**, 773 (1952).

[4] de Groot, S. R., "L'Effet Soret" (Amsterdam, 1945).

Fission of Peptide Bonds by Lithium Borohydride

The value of lithium aluminium hydride as a reagent for the characterization of the C-terminal residues of proteins has been investigated by several workers[1], but, except in the case of insulin[2], the potentialities of lithium borohydride have been less fully explored. Grassmann, Hormann and Endres[3] have described a method for the characterization of the C-terminal residues of small peptides which involved esterification followed by reduction with lithium borohydride hydrolysis and identification of the amino-alcohols produced. When a similar technique was applied to procollagen[4], amino-alcohols were obtained even from the un-esterified protein and it was concluded that carboxylic ester groupings were present. Experiments carried out in this laboratory and described below show, however, that cleavage of peptide bonds can be brought about by lithium borohydride, those bonds involving the carboxyl group of glycine or of alanine being particularly susceptible. At present, therefore, little confidence can be placed in lithium borohydride as an end-group reagent for large peptides or proteins

The reduction of small molecules, such as di- and tri-peptides, proceeds satisfactorily at 0° C or at room temperature in tetrahydrofuran solution , but esters of large peptides and proteins are not soluble in the solvent, and more vigorous conditions, that is, heating and stirring, are necessary to achieve complete reduction of the ester group , simultaneous peptide bond cleavage then occurs. Benzoylglycylalanine methyl ester was treated at 0° for 18 hr. and at the boiling point for 4 hr with five molecular proportions of lithium borohydride in tetrahydrofuran solution. After removal of excess reagent and inorganic salts the products were hydrolysed and submitted to paper chromatography. The products from the cold reduction were glycine and alaninol, as was expected, but those from the hot reduction contained in addition a significant quantity of ethanolamine as judged by the intensity of the spots

The action of lithium borohydride on lysozyme and on the mixture of peptides obtained from the fission of silk fibroin at serine residues[5] was examined quantitatively. At the outset of this investigation no method was available for the quantitative isolation and identification of amino-alcohols present in mixtures containing amino-acids and inorganic salts. This was achieved by conversion of the amino-alcohols obtained on hydrolysis of the reduction products to their 2 4-dinitrophenyl-derivatives followed by partition chromatography Details of this method will be published later. Two different procedures utilizing 2 4-dinitrophenyl-derivatives have been published recently[3,6,7]. The formyl seryl peptides from silk fibroin[5] were esterified with diazomethane and attempts were made to reduce the terminal ester groups using a solution of lithium borohydride in tetrahydrofuran at room temperature. The reaction was carried out in a thick-walled cylindrical flask containing a number of glass beads which was rotated in a horizontal position to bring about crushing of the insoluble solid. Apart from a very small amount of serinol, the only amino-alcohols isolated were alaninol and ethanolamine , but the combined yield of these was less than that expected from consideration of previous analytical data[5] even with a reaction period of three days and a large excess of reagent. When the reaction was carried out at 70–75°, much more rapid reduction occurred, the theoretical yield of amino-alcohols being obtained in about 12 hr A reaction period of 18 hr , however, gave considerably more than the theoretical quantity of amino-alcohols. The same amino-alcohols, alaninol and ethanolamine, were also obtained when the peptides were treated under these conditions with the reagent without previous esterification. The combined yield was equivalent to nearly half the C-terminal carboxyl groups present. Although the free carboxyl group of hippuric acid was reduced to a small extent under these vigorous conditions, reduction of the free carboxyl groups could not account for the large quantity of amino-alcohols obtained from the un-esterified peptides It was clearly impossible to distinguish between true end-groups and those formed by fission of the peptide chain. When lysozyme was treated in a similar way with lithium borohydride, the yields of ethanolamine and alaninol obtained were together equivalent to more than 3 C-terminal residues per molecule of weight 14,700. Appreciable quantities of serinol, valinol, phenylalaninol and leucinol (or *iso*leucinol) were also produced.

Hydrogenolysis of the C–N linkage of amides by metallo-hydrides has been observed by several workers[8] , when structural features are favourable, splitting takes place at room temperature and aldehydes are generally obtained. The formation of carbinols is also known. Apart from the greater lability of the glycine and alanine residues it appears that the polypeptide chain is attacked in a more or less random fashion by the reagent: the FDNB technique of Sanger revealed that a number of different N-terminal residues were liberated when lysozyme was treated with lithium borohydride

J. C. CRAWHALL
D. F. ELLIOTT

National Institute for Medical Research,
London, N W 7

Oct. 25

[1] For a summary of recent work, see Fromageot, C , and Jutisz, M , "The Chemical Structure of Proteins", 82 (J and A Churchill, Ltd , London, 1953)

[2] Chibnall, A C , and Rees, M W , "The Chemical Structure of Proteins", 70 (J and A Churchill, Ltd , London, 1953)

[3] Grassmann, W , Hormann, H , and Endres, H , *Chem Ber* , 86, 1477 (1953)

[4] Grassmann, W , Endres, H , and Steber, A , *Z Naturf*, 9b, 513 (1954)

[5] Elliott, D F , *Biochem J* , 50, 542 (1952), "The Chemical Structure of Proteins", 129

[6] Grassmann, W , Hörmann, H , and Endres, H , *Hoppe-Zeyl Z* , 296, 208 (1954)

[7] Jutisz, M , Privat de Garilhe, M , Suquet M , and Fromageot, C , *Bull Soc Chim Biol Paris*, 36, 117 (1954)

[8] See, for example, Weygand, F and Tietjen, D *Chem Ber* , 84, 625 (1951) Wittig, G , and Hornberger, P , *Liebigs Ann* , 577, 11 (1952) Snyder, H R , and Putnam, R E , *J Amer Chem Soc.* 76, 1893 (1954)

Protein Synthesis in the Cell Nucleus

THERE is considerable evidence that the cytoplasm of the cell contains structures capable of carrying out protein synthesis[1], and it has been shown in one case[2] that formation of protein may be little affected by removal of the nucleus. These findings seem to exclude the appealing hypothesis that the nucleus is the source of the cell's proteins. It does not follow, however, that the nucleus is incapable of protein synthesis , and in fact there has been some evidence[3] that proteins may be formed in the nucleus. The results described below seem to demonstrate unequivocally the existence of protein synthetic mechanisms that are associated with the nucleus

The experimental material was *Amoeba proteus* The conditions were basal , that is, the cells were maintained in inorganic medium without food organisms for 24 hr before the first observations and during the entire experiment. Amoebae were cut into nucleated and enucleated halves. Intact cells served as controls Immediately after cutting, whole cells and nucleated and enucleated halves were placed in inorganic medium to which methionine-^{35}S

Table 1 AVERAGED VALUES OF UPTAKE AND INCORPORATION OF METHIONINE-^{35}S AT VARIOUS TIMES AFTER CUTTING CELLS (*W* = intact cells, *N* = nucleated halves, *E* = enucleated halves)

		Hours after cutting when incubated in methionine-^{35}S 0–3	24–27	48–51	72–75
Total amount taken up	*W*	2 83	2 53	3 41	3 35
	N	1 46	1 42	1 80	1 64
	E	0 60	0 47	0 20	0 20
	W/N	1 9	1 8	1 9	2 0
	N/E	2 4	3 0	9 0	8 2
Amount incorporated into material insoluble in trichloracetic acid	*W*	2 16	2 05	2 63	2 41
	N	1 11	1 04	1 31	1 23
	E	0 18	0 17	0 07	0 06
	W/N	1 9	2 0	2 0	1 9
	N/E	6 1	6 1	18 7	20 0
Percentage incorporated	*W*	76	81	77	72
	N	76	73	73	75
	E	30	36	35	30
	W/N	1 0	1 1	1 0	0 96
	N/E	2 5	2 0	2 1	2 5

had been added, and remained there for 3 hr After external methionine had been washed away, the total amount of activity that had been taken up by each group was determined with a windowless Geiger counter Samples of fifty to seventy-five cells were sufficient In a similar manner, the methionine uptake was determined in cells transferred to the methionine solution at 24, 48 and 72 hr after cutting and left for 3 hr After the measurement of total uptake of methionine-^{35}S, the samples were extracted with 5 per cent trichloracetic acid, and the remaining activity determined This is assumed to represent methionine-^{35}S that had been incorporated into protein The term 'percentage incorporation' refers to the fraction of the methionine-^{35}S which had entered the cell and is incorporated into the material insoluble in trichloracetic acid Since it is unlikely that net accumulation of protein could occur under these basal conditions, we are in effect measuring the re-utilization of existing proteins to make new proteins

The averaged results of the experiments are given in Table 1 The point of greatest interest to the present discussion is that percentage incorporation in the enucleated half drops to a level lower than that in the nucleated half by a factor of 2 5 immediately after the cell is cut in half We observe further that while enucleation leads to a progressive decline in the uptake of methionine by the cells, it has no appreciable effect on percentage incorporation for a period of three days By considering only percentage incorporation, we can evaluate the terminal synthetic steps which put the methionine into protein without being confused by effects of the experimental treatments on the uptake or preliminary metabolism of the amino-acid The latter are interesting in themselves and will be discussed elsewhere

The immediate decline in percentage incorporation upon enucleation may be interpreted to mean that part of the protein synthetic mechanisms of the cells is localized in the nucleus Alternatively, it could mean that this fraction of protein synthesis is intimately coupled with some mechanism that is localized in the nucleus Protein synthesis associated with the nucleus under the basal conditions of the experiment is about 40 per cent of the total

The results confirm at the same time the conclusion hat the cytoplasm is capable of protein synthesis The fact that percentage incorporation in the enucleated half does not change appreciably for three lays suggests further that the cytoplasmic mechnisms operate independently of the nucleus, except ossibly on an indirect, long-term basis It will not be expected that the relative levels of the synthesis of protein associated with the nucleus and the independent synthesis associated with cytoplasm will be quantitatively the same under other conditions We would predict that the contribution of the cytoplasm will be relatively greater when the cell is growing and increasing its absolute protein content

Can we assign to the protein synthesis associated with the nucleus a role that will be relevant to the administrative function of the nucleus in the cell ? Let us assume that the routine synthesis of proteins —enzyme formation, etc —is carried out by the cytoplasm The nucleus might be synthesizing those proteins that remain within its boundaries and function there A second possibility follows from currently discussed views on the relation between the genetic system and protein synthesis There is evidence that ribonucleic acid transmits genetic information from nucleus to cytoplasm and there governs the formation of proteins[4] So far as is known, the ribonucleic acid of the basophilic material involved in protein synthesis is not free, but exists as ribonucleoprotein complexes[5] If the genetic system is not producing ribonucleic acid, but ribonucleoprotein, then protein formation associated with the nucleus may represent the synthesis of the protein part of the machinery whereby the cytoplasm makes its structural, catalytic and storage proteins

A fuller account of this work will appear in another publication The investigation was supported by a grant from the American Cancer Society (recommended by the Committee on Growth, National Research Council) and by University of California cancer funds We thank Prof Harold Tarver for methionine-^{35}S prepared in his laboratory

DANIEL MAZIA
DAVID M PRESCOTT

Department of Zoology,
University of California,
Berkeley 4, California
Oct 7.

[1] Siekevitz, P , *J Biol Chem* , 195, 549 (1952)
[2] Brachet, J , and Chantrenne, H , *Nature*, 168, 950 (1951)
[3] Lang, K , Lang, H , Seibert, G , and Lucius, S *Biochem Z* , 324, 217 (1953) Ficq, A , *Experientia*, 9, 377 (1953) Allfrey, V G , *Proc U S Nat Acad Sci* , 40, 881 (1954)
[4] Gale, E F , and Folkes, J P , *Nature*, 173, 1223 (1954)
[5] Allfrey, V , Daly, M M , and Mirsky, A E , *J Gen Physiol* , 37, 157 (1953)

A New Reagent for the Histochemical and Chemical Detection of Calcium

THE dyestuff 'kernechtrot' or nuclear fast red obtainable from G T Gurr, Ltd (batch 3569), or T Gerrard, Ltd (nuclear fast red standard), has been found to be a sensitive reagent for the detection of calcium In all instances the histochemical localizations of calcium indicated by the dyestuff have been confirmed by micro-incineration and microchemical tests Mr G T Gurr informs me that the manufacturers say that the nuclear fast red described here is an anthraquinone dyestuff, and the reactions with calcium salts parallel the reactions of other anthraquinone derivatives observed during a detailed study of histochemical methods for calcium which will be published elsewhere

The nomenclature of the dyestuffs, and related substances, to which the term 'kernechtrot' has been applied, is complicated and deceptive. The substance mentioned here should not be confused with others to which the name has been applied, that involve

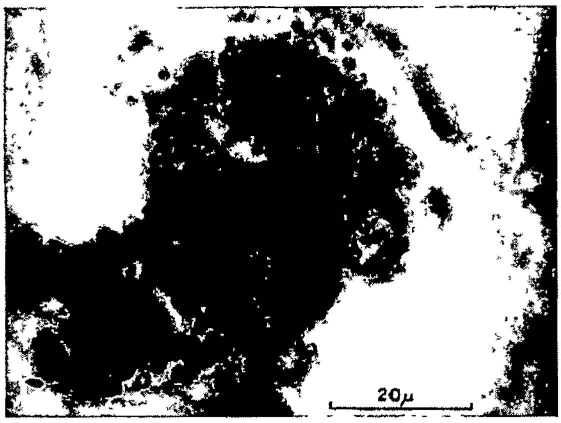


Fig. 1. Calcium cells of *Helix* digestive gland stained with calcium red reagent, showing intense coloration of individual spherules

mixtures of dyestuff with a mordanting metal salt such as aluminium sulphate, or with the diazonium salts of somewhat similar names, for example, 'kernechtrot-salz B'[1]. I propose the name 'calcium red' for the standard dyestuff referred to here, which is itself, in the commercial samples tested by paper-partition chromatography, a mixture of components.

To use calcium red as a reagent for calcium it must be purified to some extent, which may be done by taking 2 gm. of the commercial dyestuff and washing it with 100 c.c. of distilled water twice. The residue is then made up into a saturated aqueous solution (about 0.25 gm. in 100 c.c.), and this solution will react rapidly with deposits of inorganic calcium salts, producing a lake in the form of a brilliant red precipitate. The reaction depends upon the liberation of free calcium ions, and hence is affected by the solubility of the calcium salt present. The reaction does not therefore take place with the intensely insoluble oxalate, found, for example, in the left colleterial gland of the cockroach[2].

Since the method depends upon the formation of a precipitate close to the site of the original substance, it is subject to the normal type of cytological diffusion error[3]. Nevertheless, localization is usually good. A full description of the procedure will be published elsewhere. The technique has worked with complete success upon the calcium deposits found in the following tissues: digestive gland of the snail (*Helix*), digestive gland of *Anodonta*, the hepatic cæca of *Carcinides*, the malpighian tubules of the cockroach, and the glands of Swammerdam of the frog. A clear distinction must be made between the formation of the dye-lake precipitate, and staining effects which may occur between the dye, the dye-lake, and the tissue proteins and other constituents, of the mordant-staining type, which cause a general pink staining of the background. This problem will be considered elsewhere.

The reagent may be used as a supra-vital reagent; also, as the laking response is not prevented by the presence of potassium hydroxide, provided the *p*H is not too high, it is likely that calcium red will be applicable in techniques for the gross staining of skeletal structures, in a manner comparable to alizarin red S[4-6].

The reagent enables one to make an immediate distinction between tap water and distilled water. The dyestuff appears to show selectivity between the alkaline-earth metals, and aluminium and magnesium. The selectivity should be of importance in qualitative analysis, and it is hoped that this communication will bring the dyestuff to the attention of inorganic chemists.

I wish to thank Dr. J. R. Baker, Dr. W. G. B. Casselman and Dr. P. C. J. Brunet for their critical advice and encouragement. Mr. Edward Gurr and Mr. George Gurr have kindly provided me with information about the various 'kernechtrot' substances. I am grateful to Prof. A. C. Hardy for the excellent facilities of his Department. The work was carried out during the tenure of a Christopher Welch Scholarship, and a grant from the Department of Scientific and Industrial Research.

S. M. McGEE-RUSSELL

Department of Zoology and
Comparative Anatomy,
University Museum,
Oxford.
Aug. 16.

[1] Conn, H. J., "Biological Stains" (Biotech Publications, Geneva, New York, 1953).

[2] Brunet, P. C. J., *Quart. J. Micr. Sci.*, 93, 1, 47 (1952).

[3] Danielli, J. F., "Cytochemistry" (John Wiley and Sons, Inc., New York, 1953).

[4] Edwards, W. H., *Microscope*, 9, 9, 238 (1953).

[5] Sedra, S. N., *Stain Tech.*, 25, 4, 223 (1950).

[6] Williams, T. W., *Stain Tech.*, 21, 2, 55 (1946).

An Intracellular Lipoidal Cycle and its Disruption by Neutral Red

A CYTOLOGICAL study has been carried out on fixed, living and frozen-dried acinous cells of the pancreas of the mouse. Observations on fixed preparations prepared by Baker's[1] sudan black technique have shown that zymogen granules are formed from certain lipoidal prozymogen bodies which originate from mitochondria in the form of small granules. The granular prozymogen bodies migrate towards the Golgi apparatus and finally establish contact with it. It seems quite possible that the Golgi apparatus makes some contribution to the lipoidal bodies to be included in, or to facilitate, the production of zymogen. The prozymogen bodies next leave the Golgi apparatus and become vacuolated so that each one comes to consist of an outer lipoidal sheath which envelops an inner immature zymogen granule. In the zymogen zone the lipoidal sheath is lost and a mature zymogen granule makes its appearance, usually with a small particle of lipid adhering to its surface.

Zymogen secretion is brought about in a manner similar to zymogen synthesis. Among the zymogen granules a few small vacuolated bodies (1 μ in diameter) appear and increase in size at the expense of the surrounding granules. These bodies correspond with the secretion spaces[2] recorded by several workers and therefore are termed 'secretion bodies'. Each secretion body consists of an outer lipoidal coat and an inner substance which is formed by the absorption of the zymogen granules. The secretion bodies are usually extruded intact into intercellular secretion canaliculi along which they pass into the main duct system.

The sudan black method revealed no difference morphologically, apart from a slight difference in size, between vacuolated prozymogen bodies and small secretion bodies. Indeed, in some cells there was little doubt that some secretion bodies were formed by the coalescence of many small prozymogen bodies It appears, therefore, that zymogen synthesis and zymogen absorption are brought about by the activity of the same intracellular lipoidal cycle

The intracellular lipoidal cycle is synchronized with, and part of, an intracellular secretion cycle This secretion cycle consists of three main phases (1) recovery phase, during which zymogen synthesis is maximal and there are many lipoidal prozymogen bodies, (2) resting phase, during which zymogen synthesis is minimal and there are few lipoidal prozymogen bodies, and (3) discharge phase, during which zymogen granules are absorbed by lipoidal secretion bodies

When mice were each injected with 1 c c of a saturated solution of neutral red, the acinous cells eventually became filled with masses of neutral red granules These originated from mitochondria in the same way as prozymogen bodies, and in fixed preparations coloured with sudan black Morphologically they were identical with prozymogen bodies, but there was no evidence to suggest that they ever formed zymogen granules Rather, the evidence supports the view that the cells had produced large numbers of lipoidal bodies which segregated the neutral red Since there had been this great synthesis of lipid in the majority of cells irrespective of their physiological condition, it was clear that neutral red had disrupted the normal gearing of the intracellular lipoidal cycle with the secretion cycle

Dennis Lacy

Department of Zoology and Comparative Anatomy,
St Bartholomew's Medical College,
London, E C 1.

Sept 24

Baker, J R, *Quart J Micr Sci*, **90**, 293 (1949)

Nassanov, D N, *Arch f mikr Anat*, **100**, 433 (1924) Sluiter, J W, *Proc Acad Sci, Amsterdam*, **51**, 353 (1948)

Lipid Nomenclature

The following views, although divergent in some particulars from those of Fisher[1], may be useful for onsideration when the terminology of fatty subtances is revised by an international commission, and in lipid chemistry generally

It is desirable at the outset to define 'lipids' as he naturally occurring substances comprising fatty acids and their derivatives or compounds, and to ubdivide them into homolipids, heterolipids and ipid complexes according to whether they contain nly carbon, hydrogen and oxygen or these and other lements in addition, and according to whether they re true compounds or contain molecules associated y secondary valence

In the accompanying scheme, based upon the recommendations of the International Union of Chemistry's Commission on the Nomenclature of Biological Chemistry[3], the proposed nomenclature for pids is taken from the existing literature, supplemented in the case of the heterolipids with such modifications as are dictated by the necessity for ransition from empirical to systematic chemical omenclature when that is made possible by research

(The spellings 'lipid' and 'lipide' are both in common se, 'lipid' is adopted here by analogy with other ciences[2] and because of the specific chemical significance of the suffix '-ide'[2] The pronunciation ĭpĭd' is suggested by derivation from λιπος The erm 'lipoid', which was probably the most correct tymologically, has now fallen into disuse, '-ide' in glyceride, phosphatide, etc, is justified by common use)

Proposed Classification of Lipids

1 Homolipids
  - *a* Glycerides
  - *b* Ester waxes
    - (i) Cerides (higher acyl esters of long-chain primary alcohols)
    - (ii) Sterides (higher acyl esters of sterols)
  - *c* Glyceryl ether esters (higher acyl esters of glyceryl long-chain alkyl ethers, for example, selachyl alcohol)
  - *d* Etholides (alternatively estolides lactide-like condensation products of hydroxy acids)
  - *e* Lipoglycosides (higher acyl compounds of carbohydrates, etc)

2 Heterolipids
  - *A* Phospholipids
    - *a* Phosphatides (heterolipids containing phosphorus and possibly, but not necessarily, amino-nitrogen, the latter can be indicated by prefix in reference to individual compounds)
      - (i) Phosphoglycerides (phosphatidyl ethanolamine, phosphatidyl choline, phosphatidyl serine, etc)
      - (ii) Phosphoinositides
      - (iii) Phosphoglyceroinositides
      - (iv) Phosphoglyceracetals (acetal-phospholipids, formerly plasmalogens or acetal phosphatides)
      - (v) Polyphosphoglycerides (for example, cardiolipin)
    - *b* Phospholipamides (heterolipids containing phosphorus and amido-nitrogen)
      - (i) Lipamidolphosphorylamines (containing fatty amide, long-chain alcohol, phosphoric acid and base, for example, sphingomyelin)
      - (ii) Lipamidolphosphates (fatty amide, alcohol and phosphoric acid, for example, ceramide phosphates)
  - *B* Lipamides (heterolipids containing amido-nitrogen but no phosphorus)
    - *a* Ceramides
    - *b* Lipamidolglycosides (containing fatty amide, alcohol, carbohydrate and base, for example, cerebrosides)
  - *C* Sulpholipids

3 Lipid Complexes (association by accessory valence)
  - *A* Phospholipid-carbohydrate complexes
  - *B* Lipoproteins

The appellation 'ternary' is not true of cerides, etc, so listed in the International Union's classification, and the term 'complex' is more properly applied to association compounds[4]

'Phosphatide', as originally defined by Thudichum[5] to mean fatty substances containing phosphorus and possibly but not necessarily nitrogen, has been retained, but, as exemplified in the table, reference has been restricted to amino groups The term is still the one most widely used for the substances thus listed[6,7], and Channon and Chibnall[8] explicitly derived from it the name 'phosphatidic acid', a less cumbersome alternative for di-acyl glycerophosphoric acid

Afterwards, Folch[9] used phosphatidic acid as the basis for referring to the compounds formerly called lecithin and kephalin, as phosphatidyl choline and phosphatidyl ethanolamine, respectively The analogous α-amino-hydroxypropionic acid derivative is designated 'phosphatidyl serine'

Folch-Pi and Sperry[7] agreed to the retention of 'lecithin' for alcohol-soluble phospholipid fractions and 'kephalin' for the alcohol-insoluble, lecithin, thus defined, usually contains both phosphatidyl choline and ethanolamine

The isolation by Folch[10] of phosphatides of which the characteristic polyhydroxy residue is inositol led that worker and Sperry[7] to propose the term 'phosphoglyceride' for the type of substance dealt with in the two preceding paragraphs The extension of this nomenclature to 'phosphoglyceroinositides' for phosphatides containing both polyhydric residues[11] follows naturally It should be noted that the term 'glycerophosphatide', proposed by Celmer and Carter[6], is redundant and phosphoglyceride is therefore preferable to it

Although the acetal-phospholipids, formerly called plasmalogens or acetal-phosphatides[12], fall within the group defined as phosphatides, it is necessary to denote in their terminology the difference between the diacyl character of the phosphatidyl compounds and the acetal of the 'plasmalogens' The general term 'phosphoglyceracetals' is therefore proposed for them, and individual compounds[13] can be distinguished by placing the name of the nitrogenous moiety before the class name

The suggested introduction of 'phosphoglyceratid'[1] could lead to ambiguity as to whether the compound was of the glyceride or acetal type, moreover, it does not seem to offer any advantage over extant usage 'Phosphoglycolatid' is excluded as referring to a synthetic product

Regarding those heterolipids which are characterized primarily by the presence of nitrogen, it is fairly generally the case that at least one of the nitrogen atoms is present in amido linkage[14] 'Lipamide' and 'phospholipamide' therefore seem to be obviously suitable as general terms for those compounds, and they make possible a subclassification of some of the compounds listed under 'sphingolipids' by Celmer and Carter[6]

Cerebrosides (to use the current term) would remain a subgroup of lipamides In the selection of names for these subgroups, it should be borne in mind that it has recently been shown[15] that they may give rise on hydrolysis to amines other than sphingosine The inclusion of names of specific compounds such as sphingosine as roots of general terms is therefore to be avoided

Individual lipamides and phospholipamides can be specifically named, according to the proposed system, by substitution of the stem-names of the fatty acid, long-chain alcohol and base for the roots 'lip-', '-ol-' and 'amine', respectively, in the general term Sphingomyelin (although now sufficiently well known by that name to remain as such) would be lignoceramidosphingosine–choline–phosphoric acid diester Expansion of this for detail and transformation to the Geneva form, showing the compound as a substituted octadecene, present no difficulty.

The gangliosides, etc, remain for analogous treatment when their constitutions become fully known.

Acknowledgment is made to J Bibby and Sons, Ltd, for permission to publish this communication

H H. Hutt

Research Department,
J Bibby and Sons, Ltd.,
King Edward Street,
Liverpool 3

Sept 3

[1] Fisher, N, *Nature*, 173, 874 (1954)

[2] "The Shorter Oxford English Dictionary", 2nd edit (1936)

[3] Union Internationale de Chimie, Comptes Rendus (1927–28), "Thorpe's Dictionary of Applied Chemistry" (4th edit, Longmans, Green and Co, London, 1947)

[4] Wittcoff, H, "The Phosphatides", 81 (Reinhold, New York, 1951)

[5] Thudichum, J L W, "A Treatise on the Chemical Constitution of the Brain" (London, 1884), quoted by Channon and Chibnall (ref 8)

[6] Celmer, W D, and Carter, H E, *Physiol Rev*, 32, 167 (1952)

[7] Folch-Pi, J, and Sperry, W M, "Ann Rev Biochem", 17, 147 (1948)

[8] Channon, H J, and Chibnall, A C, *Biochem J*, 21 (2), 1114 (1927)

[9] Folch, J, *J Biol Chem*, 146, 35 (1942)

[10] Folch, J, *Fed Proc*, 5, 134 (1946), *J Biol Chem*, 177, 497 (1949)

[11] Folch, J, *Fed Proc*, 6, 252 (1947)

[12] Feulgen, R, and Bersin, Th, *Z physiol Chem*, 260, 217 (1939)

[13] Lovern, J A, *Nature*, 169, 969 (1952)

[14] Wittcoff, H *loc cit*, 39

[15] Carter, H E, *et al*, *J Biol Chem*, 206, 613 (1954)

Flowing Chromatography on a Circular Paper Pack

The possibility of combining the advantages of circular paper chromatography with those obtained by using an automatic fraction collector for separation and isolation of substances from a mixture has been investigated The essential features of the technique consist in the application of the method of preparative circular paper chromatography[1] for the separation of the substances on a paper pack, followed by the elution of the components by means of a device for facilitating the flow of the solvent from the edge of the paper pack Fig 1 is a diagrammatic sketch of the apparatus devised

The solution to be analysed is spotted at the centre of each Whatman No 3 (31 5 cm diam) paper and the paper pack containing four or five papers is developed according to the procedure described before[1] The paper pack is then subjected to elution In this step, when the solvent front reaches the edge of the paper, the rate of flow will be prevented unless a special device is adopted to continue the flow By serrating the edge of the paper pack as shown in Fig 1, the slowing up of the solvent speed is prevented, thereby facilitating the regular flow through the pointed ends of each of the serrated edges touching the inner surface of the funnel (*E*)

The apparatus consists of two circular glass disks (*A* and *B*) (7–8 mm thickness, 28 cm diameter) At the centre of one (*A*) of the disks is cut a round hole of 3 2 cm diam The paper pack (*C*) after preliminary development has a hole cut at the centre with a diameter of 3 2 cm and is placed between the glass disks, clamped by means of screw clamps (*D*).

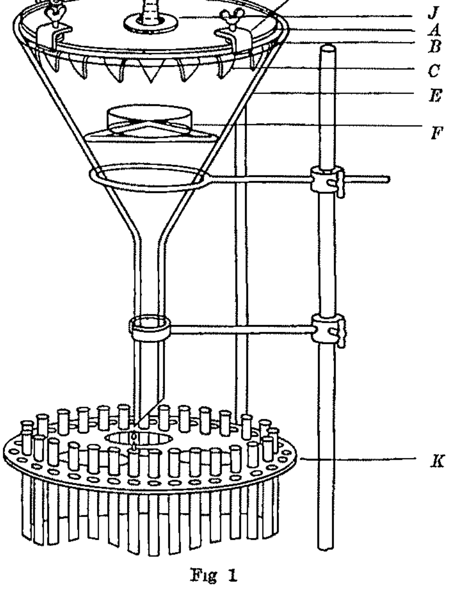


Fig 1

The paper pack with the glass disks is placed over a large funnel (*E*) (31.0 cm. diameter at the top), the pointed edges of the papers touching the inner surface of the funnel. A Petri dish (*F*) containing the solvent is placed over a glass triangular support inside the large funnel to saturate the atmosphere with the vapours of the solvent. The paper pack is then eluted with the solvent. The elution step is facilitated by the experimental arrangement shown in Fig. 1. It consists of a separating funnel (*G*) (100 c.c.) with a ground-glass joint, and another flask (*H*) (500 c.c.) which is first filled with elutant. The end of the separating funnel with the stopcock (*I*) closed is then inserted into the neck of the flask and inverted over the central hole, the neck of the funnel touching the surface of a small paper disk placed at the centre of the bottom disk. By opening the stopcock (*I*) the central well is filled with the solvent. By carefully manipulating the stopcock, the paper pack can be irrigated at a slow rate until the solvent front reaches the pointed edges of the paper. Later, the funnel (*G*) is completely filled with the solvent, and is carefully raised until the surface of the neck of the funnel is just above the surface of the bottom disk, so as to maintain a pool of solvent at the centre. A plastic ring (*J*) is placed over the solvent pool to minimize evaporation of the solvent. The stopcock is kept open until the solvent is completely drawn out. By this automatic device, continuous flow of the solvent can be maintained. The effluent coming out of the funnel (*E*) can be collected in a large number of fractions by means of an automatic fraction collector (*K*) and the fractions can be analysed according to the usual methods.

The method was applied to the separation of components from an artificial mixture of sugars and dyes. Mixtures of rhamnose (160 mgm.) and maltose (160 mgm.) (using *n*-butanol – ethanol – water), and rhamnose (200 mgm.), glucose (200 mgm.) and maltose (200 mgm.) (using butanol – acetic acid – water) were separated into fractions containing chromatographically pure components; the separation, however, was not quantitative, as some fractions contained mixtures of two sugars. A mixture containing methyl orange, neutral red and methylene blue was separated into individual components using 80 per cent ethanol as solvent.

K. V. GIRI

Department of Biochemistry,
Indian Institute of Science,
Bangalore 3, India.

D. B. PARIHAR

Defence Science Laboratory,
Hillside Road,
New Delhi.
Oct. 6.

---

[1] Giri, K. V., *Nature*, 173, 1194 (1954).

Relative Contribution of Disparity and Convergence to Stereoscopic Vision

WRIGHT'S[1] apparatus for measuring stereoscopic acuity has been modified to enable the measurements to be extended to wider separation between the tested targets. When operated in the dark, it provided two illuminated circular apertures seen against a black background. The experiments were carried out under two conditions of observation. Under condition *A*, the observer looked binocularly at one of the targets (*P*) and then to the second (*Q*). Under condition *B* the observer looked at *P* only but saw *Q* extrafoveally. In each case he was asked to estimate their relative apparent distances, and judge whether *Q* was nearer or farther than *P*.

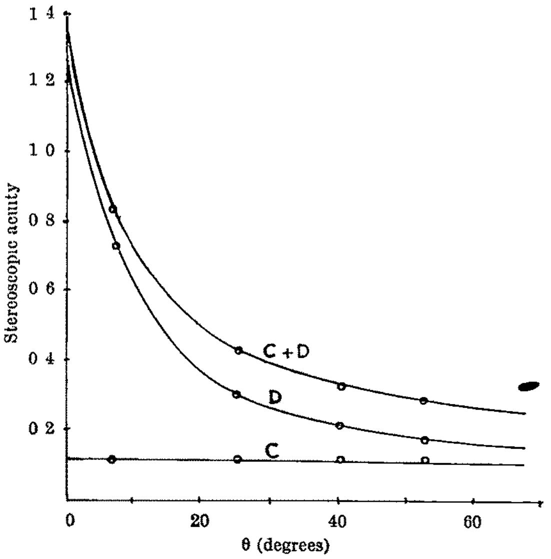


Fig. 1. Stereoscopic acuity decreases as the angle of separation (θ) between the two targets increases. *C* denotes convergence and *D* disparity

When the percentage estimates (for nearer, say) were plotted against the distance of the target *Q*, a typical psycho-physical ogive curve was obtained for each observer. From this the standard deviation was deduced as a measure for the threshold of stereoscopic vision.

Like other workers, and lately Wright, I find that acuity under condition *A* is greater than that under condition *B*, and in either case it decreases as the angle between the two targets increases. But there are conflicting views as to the explanation of the fact that stereoscopic acuity under condition *A* is higher than the corresponding value under condition *B*. The probable reason is that, under condition *A*, the convergence factor was operating, whereas under condition *B* it was absent. Since both convergence factor (*C*) and the disparity factor (*D*) co-operate in stereo-acuity, their percentage effects are considered to be simply additive.

From the experimental results, the ratio $(C+D)/D$ of the two effects can be found and so the effect of *C* alone can be isolated. Fig. 1 shows the change of either *C* or *D* with the change of the angle of separation. It shows that the role of convergence is relatively small (about 10 per cent of the stereo-acuity in the case of foveal vision), that disparity is the main factor responsible for stereoscopic vision, and that disparity does not fall below the corresponding value for convergence before an angle of separation of about 66°.

Convergence is found also to be of nearly constant value whatever may be the angle of separation. This proves that the process of convergence is nothing but a mechanical one, since the design of the eyeball enables it to rotate with great facility. Convergence is then a means of setting the eyes in the proper position for disparity to begin to act. The relatively small part played by convergence in stereoscopic vision agrees with the views of Wheatstone, Helmholtz, Valentine[2] and others.

Wright considered convergence to have a relatively important role in stereoscopic acuity, especially in the extrafovea. On the contrary, I believe his results lead to a negative value for convergence at zero angle of separation; this result cannot be understood at present.

Ogle's[3] view supports my opinion on the unimportance of the convergence factor. He assumes a fixation pause to occur between the two targets during the observation under condition *A*, and thus there will be optimal stereo-acuity when the point of convergence is half-way between these two targets. When I plot the results for condition *A* upon the same graph as condition *B* but at only half the angular separation, the two sets of observations are not greatly different. But this does not prove the adequacy of Ogle's assumption, since the fixation pause did not occur in the present experiments.

An explanation may be provided by Ogle's second assumption that the brain utilizes the information obtained during the rapid sweep of the eyes as they transfer fixation from one target to the other. The problem is still in need of further work.

A. A. Rady*

University of Ein Shams,
Egypt.
Sept. 20.

---

* Present address: Imperial College of Science and Technology, London, S.W.7.

[1] Wright, W. D., *Proc. Phys. Soc.*, B, **64**, 289 (1951).

[2] Valentine, J. A., *Brit. Med. J.*, ii, 657 (1923).

[3] Ogle, K. N., *Proc. Phys. Soc.*, B, **66**, 513 (1953).

Functional Structure of the Retinal Fovea and Maxwell's Spot

A reddish spot can be seen in the centre of the visual field when a white surface is viewed by a normal observer through a dichroic filter transmitting red and blue lights. This phenomenon is called Maxwell's spot and interpreted usually as an entoptic phenomenon due to preferential absorption of blue light in macular pigment. Among various types, the commonest is of symmetrical circular form and is made up of three concentric zones: a spot, a clear ring and a halo, going from the centre to the outside[1,2]. The central spot and the halo are reddish, and the clear ring has the same chromatic quality as the background field, which is bluish-red in most cases.

Walls[2] has reported that protanopes and protanomals saw Maxwell's spot, whereas the majority of his deuteranopes and deuteranomals did not, and this has been confirmed by our experiment. The fact that, although deuteranopes have macular pigmentation, none of them can see Maxwell's spot makes the usual explanation of this phenomenon untenable. The central floor of the fovea contains little or no macular pigment[3], so that selective absorption of blue light is inconceivable, at least in the foveal centre. Nevertheless, the central part of Maxwell's spot looks reddish in the common type of normals. In view of these facts, Walls has presented a new hypothesis of non-uniform distribution of the receptor types in the fovea. This interpretation seems to receive support from the experiment by Motokawa *et al.*[4], indicating that the excitation of the blue receptor was decidedly small at the foveal centre compared with that of the red receptor.

In order to provide more conclusive evidence for the theory, we had our subjects plot Maxwell's spot with a dichroic filter, Wratten No. 2389, and explored the spatial distribution of retinal processes by means of Motokawa's method in the same subjects under comparable experimental conditions. This method has been described in detail in a previous paper[5], so that only its principle will be mentioned here. Following a brief illumination, the electrical sensitivity of the dark-adapted eye is measured, with electrical phosphenes as an index. The sensitivity increases above normal after a brief depression, reaches a maximum in a few seconds and decreases gradually to the resting level. Percentage increases in electrical sensitivity are denoted by ζ. ζ-values at 1, 2 and 3 sec. after termination of a photic stimulus represent the magnitudes of the red (*R*), the green (*G*) and the blue (*B*) processes, for the reasons stated in the previous paper[5]. As only red and blue lights were transmitted by the filter used, the processes *R* and *B* were measured at each retinal position. As is shown in Fig. 1, Maxwell's spot of a normal subject K. M. consisted of a spot, a narrow clear ring and a halo (type II of Walls's classification). Corresponding to the deep red spot at the foveal centre, *B* was definitely small compared with *R*, while both processes were of equal magnitude at the bluish-red clear ring. In the area corresponding to the halo, *B* was found to be greater than at the foveal centre, but still smaller than *R*. This distribution accounts satisfactorily for the quality of sensations at each part of Maxwell's spot. The regional variation of the *R* process cannot be explained in terms of the macular pigment, because red light eliciting *R* is not absorbed by the pigment.

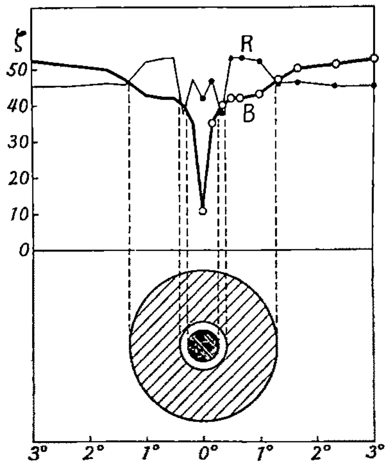


Fig. 1

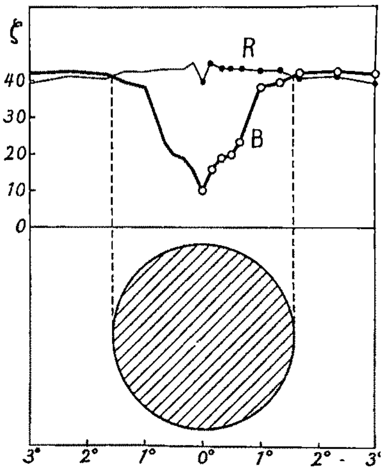


Fig. 2

Fig. 1. Spatial distribution of red (*R*) and blue (*B*) processes in fovea (above), and Maxwell's spot (below). Exploring spot of light was 2′ in visual angle during measurement of retinal processes. The more reddish-looking areas of Maxwell's spot are shaded with oblique lines

Fig. 2. Another case of normal Maxwell's spot and corresponding distribution of retinal processes

In Fig 2 another normal type is illustrated (type IV) The structure of Maxwell's spot is much simpler in this case, in good agreement with the less complicated pattern of the distribution of *R* and *B* In the foveæ of deuteranopes, *R* and *B* did not display any regional variation, as expected from the absence of Maxwell's spot

KOSAKU ISOBE
KOITI MOTOKAWA

Department of Physiology,
Tôhoku University,
Sendai
Oct 13

[1] Miles, W R , *J Neurophysiol* , 17, 22 (1954)

[2] Walls, L W , and Mathews, R W , Univ Calif Pub Psychol , 7, 1 (1952)

[3] Polyak, S L , "The Retina" (Chicago, 1941)

[4] Motokawa, K , Ebe, M , Arakawa, Y , and Oikawa, T , *Jap J Physiol* , 2, 50 (1951)

[5] Motokawa, K , *J Neurophysiol* , 12, 291 (1949)

Grouped Variations in the Occurrence of New Protein Components in Normal Human Serum

A METHOD of zone electrophoresis using starch gel as the supporting medium has been developed The advantages of zone electrophoresis and the convenience of protein detection by staining methods are combined with a resolving power in some cases superior to that obtained in free-solution boundary-electrophoresis The method has been tested with human serum proteins, with cabbage enzyme preparations[1], and with crystalline β-lactoglobulin which has been successfully resolved into its two main components[2].

The present communication reports on variations in the number and distribution of the serum proteins from normal human individuals as demonstrated by this starch gel electrophoresis A more detailed discussion of the present results and of the method, giving full experimental details, will be published elsewhere

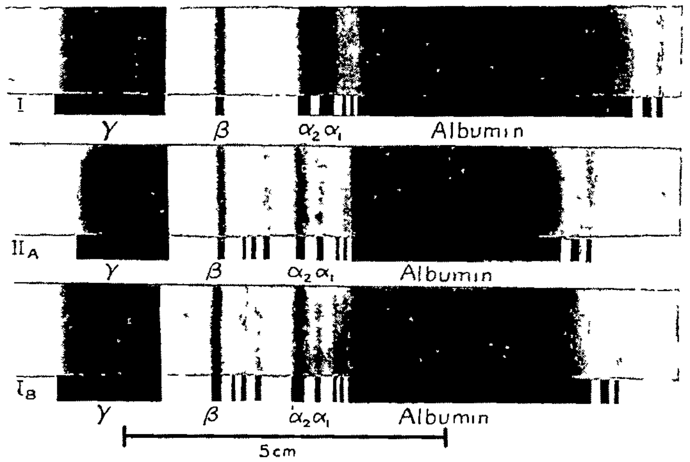


Fig 1 Photographs and explanatory diagrams of the stained gels obtained with typical sera from (top to bottom) group I, group II$_A$ and group II$_B$ Those components which show considerable variability even within a given group are not indicated in the diagrams The differences in extent of migration of the front of the albumin in the three experiments should be disregarded, they will be considered in a later publication

Sera free from visible hæmolysis products were prepared from forty-three normal individuals (twenty males, twenty-three females) In the preparation and electrophoresis of these sera the experimental procedures were carefully maintained constant

A number of previously undescribed components was observed in all the serum samples, with a variation in the number of these observable in the serum from different individuals However, all sera were found to fall into one of two main groups Sera in the first group (I) gave a pattern of protein distribution of the type shown in the upper part of Fig 1—the proteins being stained with amido-black 10*B*. This pattern resembles those obtained by conventional methods (except that several additional components present in small amounts can be seen), and the provisional identification of the main components was obtained by comparison with patterns obtained by the Tiselius and filter-paper electrophoretic methods. The second group (II) is characterized by the presence of three proteins (always absent in sera from group I) which migrate between the α_2- and β-globulins, and by the fact that the amount of protein-staining material migrating in the α_1 position is consistently much less in group II sera than in group I sera Evidence suggesting that the additional material in the α_1 position in group I sera represents a distinct protein, or proteins, absent from group II sera, will be presented in the detailed publication

The second group can be further divided into two subgroups (II$_A$ and II$_B$) The distinction between the subgroups is that the αβ proteins present in group II$_A$ sera migrate at a slightly faster rate than the αβ proteins in group II$_B$ sera Typical results obtained with sera from these two groups are presented in the lower two parts of Fig 1 The difference between such sera has been certainly established for only a limited number of those concerned (by comparing sera from the two groups on the same gel) Confirmatory cross-checks on the remaining samples are being undertaken However, on the basis of comparisons of the individual stained gels in which the αβ proteins can be seen, there is no reason for doubting the validity of the subdivision, nor was any difficulty experienced in assigning each serum to a definite group.

The number of sera in each group was found to be group I, 10 , Group II$_A$, 21 ; group II$_B$, 12

No correlation appears to exist between the serum group and the blood group (*O*, *A*, *B*, *AB*, Rh^+ and Rh^-) of individuals, and there is no significant difference in the distribution of the serum groups for the two sexes ($\chi^2 = 3\ 2$, $P = 0\ 2$)

As judged by the present results on forty-three individuals, the groups are quite discrete , but the possibility remains that intermediate types might be encountered on extending the survey A further possibility remains to be investigated more fully, namely, whether the serum group for a given individual is a permanent feature or is related to past infections My own serum showed no change of group in six months, and that from several other individuals showed no group change over much shorter periods If the constancy and discreteness of these serum groups can be confirmed, hereditary factors must be investigated

O Smithies
Connaught Medical Research Laboratories,
University of Toronto,
Toronto 5
Dec 8

---

[1] Dixon, G H, and Smithies, O (unpublished results)

[2] Smithies, O (unpublished results)

Long-Term Transplants of Infantile Rat Pituitaries cultivated *in vitro* and grafted in the Anterior Eye Chamber of Young Cats

During the past few years, we have made a number of attempts to obtain successful grafts between widely unrelated species of mammals In most of these experiments the rat was used as the donor of the graft and the cat, an animal known for its refractoriness to foreign proteins, as receptor The anterior eye chamber was chosen as the site of transplantation. In every experiment the anterior pituitary of 17-day old rats served as the graft, and kittens of between 21 and 60 days as graft receptors In all, six cats with eighteen grafts were used as controls, and seventeen cats with eighty-three grafts as experimental animals Early in the investigation it became evident that normal infantile rat pituitaries transplanted into the eye of the cat failed to survive for long periods With one exception, where the grafted pituitary tissue was still present after thirty-five days, in twenty-four days the grafts were completely resorbed, although in every case vascular connexion with the host tissue was established

If, however, the hypophysial tissue previous to transplantation was cultivated *in vitro* for fifty to sixty days at a temperature of 33–34° C in a medium containing extract of young chicken embryos (seven to nine days old)[1] the transplants survived for much longer periods (Fig 1) Even better results were obtained if the cultivated gland was first transplanted into the eye of the rat, then cultivated *in vitro* for a second time and finally grafted into the cat The length of survival of these grafts has no yet been determined, but we have some which afte three and four months of life in the host anima look quite healthy (Fig 2) In an 86-day old double explant-graft of the type described above, numerou dividing chromophobes were observed (Fig 3), and in a simple 59-day old explant-graft some dividing cells have also been found

We must emphasize the fact that we are not dealing here with an all-or-nothing reaction Some grafts both of the normal and explanted tissue, live fo longer and some for shorter periods, but on the whole, explant-grafts survive much longer than norma grafts Some double explant-grafts, however, seem capable of indefinite survival

At this stage it would be premature to speculate on the factors responsible for the prolonged surviva of grafts cultivated *in vitro* The impression is gained that more than one phenomenon is involved It would perhaps, be reasonable to assume that the chicken embryo extract exercises, in some still unknown way a protective influence upon the grafted tissue, or in other words reduces the antigenic power of the graft It is known that the anterior eye chamber present an exceptionally favourable grafting site for many kinds of tissues This may be partly due to th considerably lower temperature prevailing there in comparison with the body as a whole, it will b recalled that the incubating temperature *in vitr* was also subnormal (33–34° C)[2] Moreover, in th eye a large portion of the graft surface lies completely free, that is, not surrounded and compressed by othe tissues It is also possible that the type of biochemica reactions that take place in the eye of the host ar not injurious to the transplant We have noted on further phenomenon that may play a part in the success of grafting, namely, that after prolonged cultivation *in vitro* the gland becomes considerably tougher than the normal pituitary of comparable age

In any event, some sort of non-specific adaptation seems to play the chief part in overcoming the humora specificity of the host This view is supported by the facts that survival of the graft is promoted by cultivation in the embryo extract of a species belonging to a different class of animals, and that explant-heterotransplants that for a time have lived in the eye o

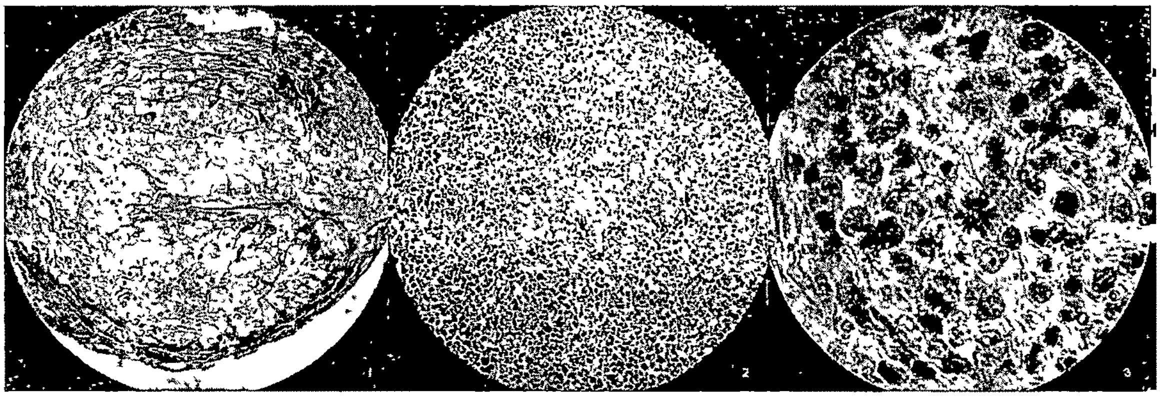


Fig 1 Anterior pituitary of a 17-day old rat grown for 56 days *in vitro* and 59 days in the anterior eye chamber of a 30-day old kitten × 80

Fig 2 Anterior pituitary of a 17-day old rat cultivated *in vitro*, then grown for 128 days in the anterior eye chamber of a hypophysectomized rat, again cultivated *in vitro* (10 days) and transplanted into the anterior eye chamber of a cat two months old, where it was maintained for 121 days × 80

Fig 3 A dividing chromophobe in the anterior pituitary explant-transplant of a 17-day old rat, cultivated *in vitro*, 128 days in the anterior eye chamber of a hypophysectomized rat, 10 days *in vitro* for a second time, and 86 days in the eye of a cat two months old × 380

the rat lived so long when transplanted into the cat. Further work is in progress

PETAR N MARTINOVITCH
DUSHANKA V. RADIVOJEVITCH
Boris Kidritch Institute for Nuclear Sciences,
Poštanski Fah 522,
Beograd, Yugoslavia.

Oct 7.

---

[1] The technique of explantation of the pituitary gland has been described by Martinovitch *J Embry Exp Morph*, 2, 14 (1954)

[2] Martinovitch, P N, "Methods in Med Research", 4, 240 (Year Book Pub Inc, Chicago, 1951), *Exp Cell Research*, 4, 490 (1953)

Paratyphoid-A Phage Typing

PHAGE-TYPING of typhoid and paratyphoid-B bacilli is now generally recognized as an indispensable aid in the control of typhoid and paratyphoid-B fever and is carried out in many countries according to internationally agreed standard methods[1]. On the other hand, the development of a useful typing procedure of *Salm paratyphi A* has been long delayed.

In 1948, Felix and Banker made an attempt to evolve a typing scheme of *Salm paratyphi A* similar to that which was first devised by Craigie and Yen[2] for the typing of *Salm typhi* The bacteriophage chosen for this purpose had been isolated in 1943 by the late Prof R. G Dhayagude from a sample of sewage in Bombay The original phage (referred to below as Bombay phage or Type 1 phage), used in very high dilutions, lysed 83 out of 132 strains of *Salm paratyphi A* isolated in distant parts of the world The remaining 49 strains were all insusceptible Only one adapted phage preparation was obtained in the course of the investigation of these insusceptible strains The adaptation had occurred on a strain isolated in southern Palestine in 1925, and the epidemiological significance of the change thereby produced in the Bombay phage was demonstrated by the fact that cultures isolated from a patient who had acquired the infection in the same locality in 1947 were found to be fully susceptible to the adapted phage (Type 2) but were resistant to the original Bombay phage[3,4]

The original and the adapted phage were afterwards employed in the routine typing of cultures freshly isolated from cases of paratyphoid-A fever occurring in Bombay and in other parts of India, but all attempts at identifying further phage types of *Salm paratyphi A* remained for a long time unsuccessful At the Sixth International Congress for Microbiology (Rome, 1953) it was reported that no further progress had been made[5]

More recently, two further adaptations of the original Bombay phage were carried out, one to a strain isolated in India (received from the Haffkine Institute, Bombay), the other to a strain isolated in Egypt (received from Commander S Barnes, U S Navy, Washington) This made it possible to subdivide *Salm paratyphi A* into four different phage types which can be easily distinguished from one another (see Table 1)

The typing scheme outlined in Table 1 is very similar to those in general use for the typing of *Salm typhi* and *Salm paratyphi B* The first place in the scheme has been assigned to the type of organism that is sensitive to the original phage and to all the adapted phage preparations derived from it. The remaining types are all characterized by their particular sensitiveness to the homologous adapted-type phage. However, on the basis of experience gained from the phage typing of *Salm typhi* and *Salm paratyphi B*, it may be predicted that future extension of the simple scheme presented in Table 1 will reveal the occurrence of cross-reactions between different phage types and will necessitate further subdivision into subtypes or varieties

The original Bombay phage at first appeared to be strictly specific for strains of *Salm paratyphi A* and was referred to by Felix[4] as a *Vi* phage acting on the specific *Vi* antigen of *Salm paratyphi A*[6] Afterwards it was found that both the original Bombay phage and the adapted Type 2 phage also lysed a number of strains of *Salm gallinarum* and *Salm pullorum*, organisms which do not contain the *A Vi* antigen. The Bombay phage, therefore, is to be considered to be an *O* phage, and the conclusion is that the phenomenon of 'adaptability' is not restricted to *Vi* phages but is one of much wider application (Felix, personal communication) The fact that the Type 2, Type 3 and Type 4 phages listed in Table 1 are fully neutralized by antiserum to Type 1 phage confirms that all these phages represent genuine adaptations of the original Bombay phage.

Thanks to the help of Dr A Felix, joint chairman and secretary of the International Committee for Enteric Phage Typing, and of many workers in different parts of the world, it has been possible to examine within a short time paratyphoid-A strains isolated in countries in all five continents It is of especial interest to note that out of more than five hundred strains examined with the four typing phages so far available, less than 10 per cent remained untypable This seems to indicate that the total number of existing phage types of *Salm paratyphi A* is not as great as that of *Salm typhi* It is known that in many parts of the world the proportion of untypable typhoid strains still continues to be greater than 10 per cent, although more than thirty different phage preparations are now being employed in the typing of this organism[5] The most common phage type of the paratyphoid-A bacillus so far encountered is Type 1 It is too early to state what is the relative frequency of the other three types

Paratyphoid-A infection is almost non-existent in Europe and America, but it is indigenous to many parts of Asia, especially India, Pakistan, Indo-China, Indonesia and other island groups of Oceania, it also occurs in Egypt and other countries of North Africa Although not so prevalent as typhoid fever in many of these regions, the incidence of paratyphoid-A fever is sufficiently high to be rated as endemic Dhayagude and Banker[7] estimated that only about 10 per cent of the enteric fever cases treated in Bombay hospitals during 1948–49 were due to *Salm paratyphi A*, the remaining being caused by *Salm typhi* However, the true incidence of

Table 1 PROVISIONAL TYPING SCHEME OF *Salm paratyphi A* ACCORDING TO FELIX AND BANKER

Type strains of *Salm paratyphi A*		Bacteriophage preparations			
		Type 1	Type 2	Type 3	Type 4
		Test dilutions			
Type	Isolated	1/20,000	1/20,000	1/10,000	1/4,000
Type 1	Bombay	*CL*	*CL*	*CL*	*CL*
Type 2	Palestine	—	*CL*	—	—
Type 3	India	—	—	*CL*	—
Type 4	Egypt	—	—	—	*CL*

CL, confluent lysis with standard loopful of test dilution of phage
—, no plaques

paratyphoid-A infection in India and in other endemic areas is not yet known and may well be much higher than that estimated for Bombay. There can be little doubt that the phage-typing method used as an epidemiological tool will prove to be an indispensable aid to the ultimate control of this infection

D. D BANKER

Department of Pathology and Bacteriology,
Seth G S. Medical College,
Parel, Bombay 12.
Dec 15.

---

[1] Craigie, J , and Felix, A , *Lancet*, i, 823 (1947) Felix, A , and Callow' B R , *Lancet*, ii, 10 (1951)

[2] Craigie, J , and Yen, C H , *Canad Pub Health J* , 29, 448, 484 (1938)

[3] Felix, A , Report to Int Com for Enteric Phage Typing, Fifth Int Congress Microbiol , Rio de Janeiro, August 1950

[4] Felix, A , *Brit Med Bull* , 7, 153 (1951)

[5] Felix, A , Report to Int Com for Enteric Phage Typing,S ixth Int Congress, Rome, September 1953

[6] Felix, A , *J Hyg* , 50, 540 (1952)

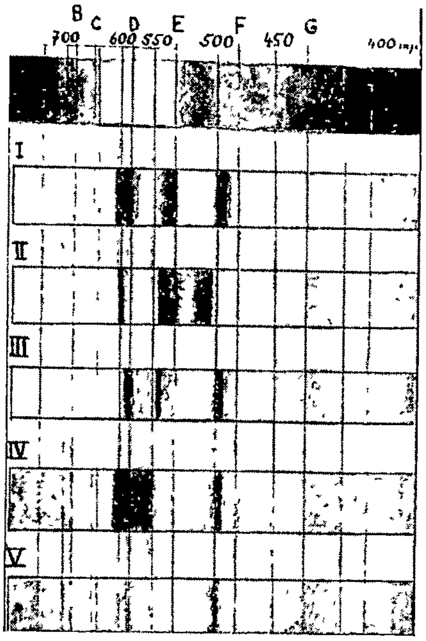
[7] Dhayagude, R G , and Banker, D D , *Ind J Med Res* , 39, 1 (1951)

Nature of the Pigment of *Aplysia depilans*

BY heating an aqueous solution of the actual excretion of the Mediterranean sea-slug *Aplysia depilans*, the violet pigment is separated from its protein part The colour of the aqueous solution varies conformably with the *p*H, from blue (*p*H 1–2) to garnet red (*p*H 8–12 0)

The chloroform solutions of this pigment exhibit maxima at 6100, 5350, 4975 and 3800 A (spectrum I), and they yield violet, red and green zones upon a column of powdered sugar The violet pigment is absorbed in the top of the column, while the red is absorbed in the middle part, and the green pigment, travelling faster, at the end of the column

Elution with chloroform–ethanol mixture (2 1) the chromatographically separated violet pigment exhibits maxima at 5860, 5290, 4925 A , and its zinc complex salt at 6280, 5927, 5440 and 5040 A. (III) The red pigment shows maxima at 5910, 5315 and 5007 A Its zinc complex salt shows maxima at 5950 5500 and 5015 A. (II) The third greenish-blue pigment shows no absorption maxima in the visible range, but an extinction of colour in the violet and red regions of the spectrum. Unfortunately, because of its very low concentration, we could not distinguish absorption bands.



The ethanolic solutions of all three pigments separated show intensive red-brownish fluorescence The chloroform solutions of the actual pigment, as well as the solutions of the three pigments separated, become dark blue when treated with a stream of dry hydrogen chloride This blue chloroform-soluble pigment exhibits maxima at 5950, 5475 and 4927 A (IV), and gives with zinc acetate a reddish-brown fluorescence with maximum at 5982, 5495 and 5055 A and simultaneous extinction in the red and violet regions. After several hours, the blue pigment becomes greenish, and its spectrum shows an intense extinction in the red to 5583 A , with only a maximum at 4955 A (V) , its zinc complex salt exhibits maxima at 6255 and 4983 A

The Gmelin reaction of these compounds is negative or very atypical. This fact, in combination with the red fluorescence, suggests that they are porphyrin in nature[1] They do not behave like bilichromes[2].

Details of this work will be published in the *Bulletin of the Academy of Sciences, Athens*

A. CHRISTOMANOS

Sea Animals Biochemical Research Laboratory,
St. George, Limni,
Euboea Island, Greece.
Oct 10.

---

[1] *C R Soc Biol*, *Paris*, 92, 1030 (1953) Fox, "Animal Biochromes and Structural Colours" (Cambridge Univ Press, London, 1953)

[2] Lederer and Hutter, *Trans Mem Soc Chim Biol* , 1055 (1942)

Peculiar Stratified Shape of Typhoon Waves

WHILE M.V. *Tancred* of the Barber Line was riding out the typhoon of early October 1954 in Kobe Bay, we were able to observe a unique shape of typhoon wave which, so far as we know, has not been described. The vessel was hove-to with two anchors down facing the incoming gale (133 km /hr) and the waves with crests up to 10 and 15 ft were passing neatly along her side. From the rail we were struck by the peculiar appearance of the wave-slopes facing the wind

On many of these there were a number of well-defined steps, carved so to say into the water just like the steps of a ladder, starting from the trough of the wave up to about half its height. Although the waves were moving quickly the steps remained steady, extending parallel to each other for one or two metres in length There were at times as many as twenty of these nicely successive steps cut into the body of the wave. We tried to photograph them, but the very poor visibility and the fast motion of the waves resulted only in a blurred print

Were these steps carved in the wave slopes by high harmonics of the period of the typhoon squalls ? These higher harmonics have been registered by sensitive modern microbarographs, and they might have something to do with the quite peculiar screaming of the wind, often reported by seamen during the squalls of tropical storms. Strangely enough, this peculiar whistling has never been noticed in the squall line of extratropical storms

E GHERZI, *S.J*

St Louis University,
St Louis 3, Missouri

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, February 14

University College London (in the Physiology Theatre Gower Street, London, W C 1), at 4 45 p m —Dr Esmond E Snell (University of Texas) "The Relationship of Structure to Catalytic Activities of Vitamin B_6" *

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W C 1), at 5 30 p m —Prof D J O'Connor "Determinism and Predictability"

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place London, W C 2) at 6 p m —Discussion on "Teaching Faraday's Law of Electromagnetic Induction"

Pharmaceutical Society of Great Britain (at 17 Bloomsbury Square London, W C 1), at 7 30 p m —Dr K R Capper "The British Pharmaceutical Codex 1954 and the National Formulary 1955"

Tuesday, February 15

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S W 1), at 5 30 p m —Mr R W Douglas "Properties of New Semi-Conductor Materials"

Institution of Civil Engineers (at Great George Street, London, S W 1), at 5 30 p m —Mr Fred Tattersall, Mr T R M Wakeling and Mr W H Ward "Investigations into the Design of Pressure Tunnels in London Clay"

Institution of Electrical Engineers, Measurements Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr W E Harris Informal lecture on "The Service Engineer at an Atomic Energy Establishment"

Society of Chemical Industry, Agriculture Group (at the Chemical Society Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr B M Church "Recent Aspects of Fertilizer Practice", Dr G W Cooke "Present Fertilizer Practice and Future Possibilities"

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m —Prof J N Davidson "Nucleoproteins in Cell Structure" (From a Series of Lectures on "The Scientific Basis of Medicine")*

University of London (in the Anatomy Theatre, University College Gower Street, London W C 1), at 5 30 p m —Mr W K Taylor "A Mathematical Model of Neuronal Interaction" *

Royal Aeronautical Society, Graduates' and Students' Section (at 4 Hamilton Place, London, W 1), at 7 30 p m —Discussion—"Is Postgraduate Study Abroad Worthwhile ?" Chairman Sir Arnold Hall F R S

Wednesday, February 16

Institute of Metals, Metallurgical Engineering Committee (at the University, Edgbaston, Birmingham), at 10 30 a m —Informal discussion on "The Treatment of Swarfs, Sawings and Residues in the Non-Ferrous Metal Industries"

Royal Meteorological Society (at 49 Cromwell Road, South Kensington London, S W 7), at 5 p m —Dr E B Kraus "Meteorology in a Large Water Engineering Project".*

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 15 p m —Discussion on "The Teaching of Mathematical Statistics at University Level"

Eugenics Society (at the Royal Society Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mrs Judith Hubback "The Fertility of Educated Women" *

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W C 1), at 5 30 p m —Dr E S Horning "Hormones in Relation to Cancer"

Royal Institute of Chemistry (in the Chemistry Lecture Theatre, King's College, Strand, London, W C 2), at 6 30 p m —Prof Sir E C Dodds, F R S "Some Recent Advances in Biochemistry"

Society of Chemical Industry, Corrosion Group (at the Chemical Society, Burlington House, Piccadilly, London W 1), at 6 30 p m —Discussion on "Corrosion Prevention in the Home"

Thursday, February 17

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Scientific Papers

University College, London (in the Physiology Theatre, Gower Street London, W C 1), at 4 45 p m —Dr S R Elsden "Respiratory Mechanisms in Bacteria" * (Further Lectures on February 24 and March 3)

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 5 p m —Scientific Papers

Linnean Society of London (at Burlington House, Piccadilly, London, W 1) at 5 p m —Prof Irene Manton "Flagella Structure Based on Observations with the Electron Microscope", Dr J R G Bradfield "Fibre Patterns in Animal Cilia and Flagella"

Institution of Electrical Engineers, Utilization Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr P J Bhatt "An Introduction to the Study of Servo-Mechanisms", Mr E J Davies "The Development of 50 c/s Traction in France", Mr G Gascoigne "Electricity Applied to Oil Production"

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m —Prof J H Gaddum, F R S "The Effects of Alcohol" * (From a series of lectures on "The Scientific Basis of Medicine")

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S W 1), at 6 p m —Dr R N J Saal (Amsterdam) "A Study on the Significance of the Bitumen Ductility Test"

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Mr H L Cox "Problems Associated with Stress Concentration"

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Scientific Papers

Royal Society of Tropical Medicine and Hygiene (at [redacted] House, 26 Portland Place, London, W 1), at 7 30 p m —Colonel H W Mulligan "Recent Investigations on Trypanosomiasis in British West Africa"

Friday, February 18

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S W 7), at 5 p m —Mr H C Pritchard "Automatic Dead Reckoning Instruments"

Physical Society, Acoustics Group (at the Royal Festival Hall, South Bank, London, S E 1), at 5 p m —Mr Ralph Downes, Mr C T L Harrison and Dr W H George "Musical and Acoustical Aspects of the Festival Hall Organ"

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Prof F Bergel "Attempts at Chemotherapy of Malignant Diseases" *

Society of Chemical Industry, Chemical Engineering Group (joint meeting with the Fine Chemicals Group, at King's College, Strand, London, W C 2), at 7 p m —Mr W C Peck "Some Applications of Chemical Engineering in the Fine Chemicals Industry", Mr A S D Barrett "Vacuum and Freezedrying"

Royal Institution (at 21 Albemarle Street, London W 1), at 9 p m —Dr J McG Bruckshaw "The Implications of Rock Magnetism"

Saturday, February 19

Biochemical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 11 a m —Symposium on "The Biochemistry of Vitamin B_{12}"

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S E 23), at 3 30 p m —Mr A J Arkell "The Magical Statuettes of Ancient Egypt" *

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Biochemist (preferably with an honours degree or equivalent qualification) in the Chemical Pathology Laboratory—Prof Gray, Department of Chemical Pathology, King's College Hospital, Denmark Hill, London, S E 5 (February 15)

Lecturer (with a degree or other high qualifications in pure or applied chemistry) in Textile Chemistry and Dyeing—The Registrar Nottingham and District Technical College, Shakespeare Street, Nottingham (February 15)

Lecturer (with a degree or other recognized qualification in geology, together with some practical experience) in Geology—The Registrar, Nottingham and District Technical College Shakespeare Street, Nottingham (February 15)

Assistant Lecturer (with a degree in engineering and/or agriculture with practical experience in farm implements and machinery) in Agricultural Engineering—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (February 16)

Lecturer in Biology—The Principal, Borough Road College, Isleworth, Middlesex (February 21)

Lecturer in Applied Mathematics—The Registrar, King's College, Newcastle-upon-Tyne (February 28)

Lecturer or Assistant Lecturer in the Department of Botany—The Secretary, Bedford College, Regent's Park, London, N W 1 (February 28)

Lecturer (preferably with a university degree in physical chemistry or chemical engineering) in Chemical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (February 28)

Assistant Lecturer (female) in Mathematics, and an Assistant Lecturer in Physics—The Principal, Royal Holloway College, Englefield Green, Surrey (March 1)

Chair of Anatomy at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, March 1)

Cripps Chair of Production Engineering—The Registrar, The University, Nottingham (March 1)

Research Assistant (trained in physiology and/or biochemistry) in the Department of Anæsthetics—The Registrar, The University Leeds 2 (March 1)

CHAIR OF PUBLIC HEALTH AND SOCIAL MEDICINE—The Secretary, The University, Edinburgh (March 8)

ASSISTANT STATISTICIAN (with a pass degree or equivalent qualification, and preferably with a knowledge of mathematics and horticulture (or botany)) for the examination and analysis of experimental data—The Secretary, East Malling Research Station, near Maidstone, Kent (March 15)

CHIEF LECTURER IN PHYSIOLOGY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, March 15)

LECTURER or ASSISTANT LECTURER IN GEOGRAPHY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (March 15)

CHAIR OF AGRICULTURE, at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham (March 16)

LECTURER Grade 2 (with experience in either experimental or theoretical nuclear physics) IN THE DEPARTMENT OF PHYSICS, and an ASSISTANT LECTURER or LECTURER IN THE SUB-DEPARTMENT OF ACOUSTICS—The Registrar, The University, Liverpool (April 14)

[illegible]TURER or ASSISTANT LECTURER (with a degree in pharmacy, or Fellow of the Pharmaceutical Society) IN PHARMACEUTICS, at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies 1 Gordon Square, London, W C 1 (April 15)

I C I RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W C 1 (April 16)

TURNER AND NEWALL RESEARCH FELLOWS IN ENGINEERING, INORGANIC CHEMISTRY, PHYSICS or an allied subject—The Academic Registrar, University of London, Senate House, London, W C 1 (April 16)

ASSISTANT LECTURER (with good academic qualifications, and appropriate teaching and other experience) IN PHYSICS, at Flintshire Technical College—The Director of Education, County Education Offices, Mold, Flintshire

CHEMISTS (Scientific Officer grade) IN THE BIOCHEMISTRY DEPARTMENT, to help in research on the formation of heterocyclic compounds in plants—The Secretary, Rothamsted Experimental Station, Harpenden, Herts

EDITORIAL ASSISTANT (with a knowledge of chemistry)—The General Secretary, Society of Chemical Industry, 56 Victoria Street London, S W 1

GENERAL EXPERIMENTAL PHYSICIST, Principal Scientific Officer or Senior Scientific Officer grade (with at least a first- or second-class honours degree in physics and several years general physical research experience), with the United Kingdom Atomic Energy Authority, Foulness, Essex, for the investigation of detonation phenomena—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 328/WGE/2

HEAD (preferably with teaching, industrial and/or research experience) OF THE CHEMISTRY AND APPLIED CHEMISTRY DEPARTMENT—The Principal, Royal Technical College, Salford 5

LABORATORY TECHNICIAN (fully trained in physiological techniques) —The Administrative Officer, Sir William Dunn School of Pathology, University of Oxford

LECTURERS (with a degree or higher national certificate in electrical engineering or physics, and capable of training staff varying from operator to graduate) IN THE ENGINEERING TRAINING DEPARTMENT, Evesham—Engineering Establishment Officer, B B C, Broadcasting House, London, W 1, quoting EX 22N

MATHEMATICIANS (with a first- or second-class honours degree in mathematics, and preferably with some research experience in an applied field) at various Ministry of Supply Research and Development Establishments in Southern England—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 28/5A

PLANT PHYSIOLOGIST (with at least four years experience beyond the doctorate level in plant physiology, plant biochemistry or cytology (other than cytogenetics)) IN THE DIVISION OF APPLIED BIOLOGY, National Research Council, Ottawa, for fundamental research on problems of photosynthesis and related metabolism, translocation, tissue culture or cell physiology, to be carried on independently or in collaboration with others—The Director, Division of Applied Biology, National Research Council, Ottawa, Ontario, Canada

PRINCIPAL (with high academic qualifications and appropriate educational and administrative experience) OF THE NORTHERN POLYTECHNIC—Clerk to the Governing Body, Northern Polytechnic, Holloway, London, N 7

RESEARCH ASSISTANT (female), Assistant Experimental Officer or Scientific Officer grade, for duties which are concerned with research on serology of viruses—The Secretary, Foot-and-Mouth Disease Research Institute, Pirbright, Surrey

RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY for work on the mechanisms of changes produced in polymers by radiations—The Secretary, The University, Edgbaston, Birmingham 15

SENIOR LABORATORY ASSISTANT (with good industrial or other laboratory experience, and able to undertake the supervision of juniors) IN THE CHEMISTRY SECTION of the Department of Applied Science—The Principal, Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton

SENIOR SCIENTIFIC OFFICER (with at least a second-class honours degree in metallurgy or equivalent, and with three years postgraduate research experience), at Sellafield, Cumberland, to undertake metallographic studies with particular reference to the behaviour of materials under irradiation and to welding of rare metals—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P O Box 19, Risley, Warrington, quoting 796

TECHNICIAN IN THE BIOLOGICAL SECTION of the Department of Clinical Endocrinology, for duties which will include routine biological assays and assistance with biological research—The House Governor, Birmingham and Midland Hospital for Women, Showell Green Lane, Sparkhill, Birmingham 11

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research Building Research Station National Building Studies Research Paper No 24 A Study of the Interreflection of Daylight Using Model Rooms an Artificial Skies By Dr R G Hopkinson and J Longmore Pp vi+24+1 plate (London H M Stationery Office, 1954) 2 net [301

Philosophical Transactions of the Royal Society of London Series A Mathematical and Physical Sciences No 927, Vol 247 (30 Novembe 1954) The Semi-Diurnal Tides Along the Equator in the India Ocean By L A Fairbairn Pp 191–212 7*s* No 928, Vol 24 (30 November 1954) Homogeneous Dynamos and Terrestrial Magnetism By Sir Edward Bullard and H Gellman Pp 213–278 2 (London Royal Society, 1954) [301

Colonial Office Colonial Research 1953–1954 Reports of th Colonial Research Council, Colonial Products Council, Coloni Social Science Research Council, Colonial Medical Research Committee, Committee for Colonial Agricultural, Animal Health an Forestry Research, Colonial Insecticides Committee, Coloni Economic Research Committee, Tsetse Fly and Trypanosomias Research Committee, Colonial Fisheries Advisory Committee Director—Anti-Locust Research Centre, and Research Matters no covered by the above Reports of the Specialist Advisory Bodie Pp 278 (Cmd 9303) (London H M Stationery Office, 1954 7*s* 6*d* net [301

Department of Scientific and Industrial Research Forest Produc Research Special Report No 8 The Dielectric Properties of Woo By R F S Hearmon and J N Burcham Pp iv+20 (London H M Stationery Office, 1954) 1*s* 6*d* net [31

The Study of Prehistory—an Inaugural Lecture By Prof J G Clark Pp 35 (London Cambridge University Press, 1954) 2*s* 6 net [31

British Engine Boiler and Electrical Insurance Co, Ltd Technica Report—New Series, Vol 2 Pp 256 (Manchester British Engin Boiler and Electrical Insurance Co, Ltd, 1954) 12*s* 6*d* [31

Building Research Station Digest No 71 (November 1954) Fro Up or Frog Down Pp 3 (London H M Stationery Office, 1954 3*d* [31

Other Countries

Arbeitsgemeinschaft fur Forschung des Landes Nordrhein-Westfale Heft 29 Das Problem der Residuen bei Lernvorgängen Von Bernhar Rensch Über Leberschaden dei der Bestimmung des biologische Wertes verschiedner Eiweisse von Mikroorganismen Von Herman Fink Pp 86 (Koln und Opladen Westdeutscher Verlag, 1954 6 D marks [301

Canada Department of Northern Affairs and National Resource National Museum of Canada Bulletin No 132 Annual Report of th National Museum of Canada for the fiscal year 1952–53, Pp iv+31 (18 plates) (Ottawa Queen's Printer, 1954) 1 50 dollars [301

Istituto Superiore della Poste e Telecomunicazioni—Roma L VII Assemblea Plenaria del Comitato Consultivo Internazionale dell Radiocomunicazioni (C C I R), Londra, 1953 (Monografia No 128 Pp 95 (Roma Istituto Superiore della Posta e Telecomunicazion 1954) [301

Académie Royale de Belgique Classe des Sciences Mémoires— Tome 28, Fasc 6 Colloque Junius Massau tenu a Mond et Gand, le 26 et 27 Avril, 1952 Sous la présidence de M J Pérès (Comit National de Méchanique théorique et appliquée) Pp 74 (Bruxelles Académie Royale de Belgique, 1954) 60 francs [301

Comision Nacional de Astronomia, Madrid Publicacion No 1 Resultado de la Observaciones del Paso de Mercurio por Delante d Disco Solar del 14 de Noviembre de 1953, Efectuadas en los Observatori Espanoles Por Jose M Torroja Pp 29 (Madrid Observatori Astronomico, 1954) [301

Behringwerk-Mitteilungen—Heft 29 Hundertjahrfeier der Geburtstage von Paul Ehrlich und Emil von Behring in Frankfurt-Mai Marburg-Lahn und Hoechst Verleihung der Emil von Behring Preise 1948, 1952 und 1954 Zusammengestellt von Dr A v Engelhardt Pp i+127+29 plates (Marburg/Lahn N G Elwert Universitäts- und Verlagsbuchhandlung, 1954) [301

Norsk Polarinstitutt Skrifter No 103 Studies on the Avifauna o Spitsbergen By H L Løvenskiold Pp 131 16 kronor Meddelelse Nr 77 De Gamble Trankokerier pa Vestspitsbergens Nordvesthjorn og den Formodede Senkning av Landet I ny Tid Av Rolf W Freyling-Hanssen Pp 75–98 2 kronor (Oslo A W Brøggers Boktrykkeri A/S, 1954) [301

Anais da Academia Brasileira de Ciencias Vol 26, No 1 P ii+228+10 plates (Rio de Janeiro Academia Brasileira de Ciencias 1954) [301

U S Department of the Army Beach Erosion Board—Corps o Engineers Technical Memorandum No 41 Laboratory Study o Equilibrium Profiles of Beaches By Ralph L Rector Pp iv+38 Technical Bulletin No 46 Field Investigation of Wave Energy Los in Shallow Water Ocean Waves By Charles L Bretschneider Pp v+42 Technical Memorandum No 50 Statistical Significance o Beach Sampling Methods By W C Krumbein Pp iii+33 Technica Memorandum No 51 Generation of Wind Waves over a Shallow Bottom By Charles L Bretschneider Pp iv+24 Technical Memorandum No 53 Laboratory Study of Effect of Varying Wave Period on Beach Profiles By George M Watts Pp iii+19 (Washington D C Beach Erosion Board, Corps of Engineers, 1954) [301

Astronomical Papers prepared for the use of the American Ephemeri and Nautical Almanac Vol 14 Solar Coordinates 1800–2000 B Paul Herget Pp xi+735 (Washington, D C Government Printin Office, 1954) 5 dollars [301

West African Institute for Oil Palm Research Quarterly Progres Report No 10 (July 1st, 1954 to September 30th, 1954) Pp 16 (Beni City West African Institute for Oil Palm Research, 1954) [301

New Books

Electrolyte Solutions

By R A ROBINSON, D Sc, Ph D, F R I C, *Professor of Chemistry, University of Malaya, Singapore,* and R H STOKES, Ph D, D Sc, F R A C I., A R I C, *Reader in Physical Chemistry, University of Western Australia*

A detailed account of the present state of knowledge of some of the most fundamental properties of electrolytes, conductance, chemical potential and diffusion, from the standpoint of the practical electrochemist

Modern experimental methods are discussed at some length, and extensive results are given, together with numerous tables useful in computations on electrolyte solutions

Price 56s.

Fundamentals of Radiobiology

By Professor Z M BACQ, University of Liège, and P ALEXANDER, Ph D, Chester Beatty Research Institute

This book, written by a biologist and a physical chemist in collaboration, presents a balanced and coherent account of our present state of knowledge of radiobiology The importance of the subject for radiotherapists using radiation in the treatment of cancer, the necessity of avoiding the hazards to the health of the community in this age of nuclear fission, and the value of radiation in fundamental research on the cell have caused a great increase of late years in the number of those engaged in radiobiology, and this number is rapidly increasing This survey of the field as a whole therefore appears at an opportune time It will enable the specialist to assimilate developments in fields adjacent to his own and appreciate their possible effects on his particular work, and will provide those newly entering the field with a guide and an assessment of the present state of research Price 40s.

BUTTERWORTHS SCIENTIFIC PUBLICATIONS
88 KINGSWAY LONDON W.C.2

The Policy for Children

£12 a year invested for a child will provide benefits at age 18, 21, or 25. The investment may be made by a parent or friend.

e.g. If the investment is begun within two months of birth it will provide, at age 21, £323 in cash, or a life policy for £1,656.

The Equitable Life Assurance Society

(founded 1762)

19, Coleman Street, London, E C.2

No shareholders. No commission

We have just published an additional list of

400

Organic Chemicals

and invite you to write for a copy

★

L. LIGHT & CO. LTD.
POYLE · COLNBROOK · BUCKS

LECTURES AND COURSES

GRESHAM LECTURES

Dr W H Steavenson, F R A S (Gresham Professor in Astronomy) will deliver a course of four lectures entitled "Planets and Satellites" on Monday to Thursday, February 14 to 17 at Gresham College, Basinghall Street, E C 2

The lectures are free and begin at 5 30 p m

UNIVERSITY OF LONDON

A course of three lectures on "The Strain of Rock in Mountain-Building Processes" will be given by Professor L U de Sitter (Leiden) at 5 30 p m on February 22, 24, and 25, at Imperial College of Science and Technology (Geology Lecture Theatre), Prince Consort Road, South Kensington, S W 7

Admission free without ticket

JAMES HENDERSON,
Academic Registrar

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order* 1952

COMMONWEALTH AGRICULTURAL BUREAUX

COMMONWEALTH INSTITUTE OF ENTOMOLOGY

Applications are invited for an appointment as Acarologist, whose principal duty will be the determination of phytophagous and predatory mites of economic importance, but who would also enjoy excellent opportunities for general systematic work in the Acarina Candidates are sought who show evidence of special interest or achievement in this field The successful candidate would work in the British Museum (Natural History) London The salary will be in a scale that rises from £530 by annual increments to £1,540 per annum with efficiency bars at £855 and £1,150 There is also a pay supplement that runs from £25 at £530 to £35 at £900 to £1,500 The starting salary will be determined by age, qualifications and experience Superannuation will be provided for under the F S S U

The closing date for applications is April 30 1955, and full details of the appointment and methods of application can be obtained from the Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S W 7

UNIVERSITY OF DURHAM

KING'S COLLEGE NEWCASTLE UPON TYNE

DEPARTMENT OF MATHEMATICS

The Council of King's College invite applications for a Temporary Lectureship in Applied Mathematics The appointment will be for the academic year 1955-56 only and the salary will be determined at a suitable point within the range £650 to £1 350 in accordance with the qualifications and experience of the successful candidate Family allowance and F S S U

Further particulars may be obtained from the undersigned to whom applications (three copies) together with the names of three referees, should be addressed so as to reach him not later than February 28, 1955

G R HANSON,
Registrar of King's College

UNIVERSITY OF DURHAM

KING'S COLLEGE NEWCASTLE UPON TYNE

LECTURER IN CHEMICAL ENGINEERING

The Council of King's College invite applications for a Lectureship in Chemical Engineering Applicants should preferably hold a university degree in physical chemistry or in chemical engineering The initial salary will be fixed at a suitable point on the scale £650 by £50 to £1 350 in accordance with the qualifications and experience of the successful applicant Family allowance and F S S U Duties to commence in October, 1955

Twelve copies of application, together with the names of three persons to whom reference may be made, should be submitted not later than February 28, 1955 to the undersigned, from whom further particulars may be obtained

G R HANSON,
Registrar of King's College

SHORT SERVICE COMMISSIONS IN THE INSTRUCTOR BRANCH OF THE ROYAL NAVY

Applications are invited from university graduates and qualified teachers under 36 years of age for Short Service Commissions of 3, 4, or 5 years in the Instructor Branch, Royal Navy Applications will also be accepted from final year undergraduates, and these will be considered in anticipation of their degree results Requirements are mainly for officers with qualifications in mathematics, science (physics, chemistry, metallurgy), or engineering, but a few vacancies exist for officers with qualifications in history or English with a sound mathematics or science background After two years' service, officers will be eligible for selection for permanent commissions A Short Service engagement in the Instructor Branch will discharge any candidate's obligation under the National Service Acts Entry will be in two grades Selected candidates with first- or second-class honours degrees receive approximately £410 in their first year's service, £429 in second year, £548 in third and fourth years, £584 in fifth year Other candidates receive £319 in first, £392 in second and third years, £429 in fourth and fifth years Previous officer service will be recognized for adjustment of seniority and rate of pay on entry Accommodation and rations are provided or allowances in lieu Married officers if aged 25 or over receive marriage allowance of £338 per annum if not accommodated in official married quarters, £283 per annum if they are so accommodated Married officers under the age of 25 receive marriage allowance of £146 per annum, but are not entitled to be accommodated in official married quarters An initial outfit allowance of £115 is paid, together with a free issue of certain articles of clothing A reduced allowance is payable to candidates with previous Naval Service as officers Tax free gratuities of £300, £400 or £500 are payable at the end of 3, 4 or 5 years respectively Instructor Officers serve both ashore and afloat and their duties include both technical instruction and general education Officers with suitable qualifications may also be trained and appointed for full- or part-time meteorological and weather forecasting duties Service in the Instructor Branch will, in the case of officers who enter from contributory service under the Teachers (Superannuation) Acts, be treated as contributory service, contributions being deducted from the above gratuities Other officers may have their service in the Instructor Branch similarly treated if they so desire

Fuller details and application forms may be obtained from Director (P), Naval Education Service, Admiralty, London, S W 1 Completed application forms should be returned, if possible, before May 31, 1955

UNIVERSITY OF LONDON

The Senate invite applications for the Chair of Applied Science, with special reference to engineering tenable at the Imperial College of Science and Technology (salary not less than £2,100 a year)

Applications (ten copies) must be received not later than March 7 1955, by the Academic Registrar University of London, Senate House W C 1 from whom further particulars may be obtained

LOTHIANS RIVER PURIFICATION BOARD

Applications are invited for the post of River Inspector for the area of the Board Salary is £1,000 by £50 to £1 250 and the statutory qualifications are corporate membership of the Royal Institute of Chemistry and of the Institute of Sewage Purification Candidates with other appropriate qualifications may be considered The superannuation scheme involves medical examination

Applications giving age, qualifications appointments held (with dates and salaries) along with testimonials should reach the Clerk Lothians River Purification Board, City Chambers, High Street, Edinburgh, 1, not later than February 28, 1955

J STORRAR
Clerk of the Board

SENIOR EXPERIMENTAL OFFICER REquired by the United Kingdom Atomic Energy Authority at Sellafield Cumberland to undertake experimental work in metallurgy and physics Qualifications At least higher school certificate in science subjects, or equivalent, with several years' appropriate experience in an industrial laboratory Salary Range £1 090 to £1,285 Contributory pension scheme—Applications to UNITED KINGDOM ATOMIC ENERGY AUTHORITY, Industrial Group Headquarters, P O Box 19, Risley, Warrington quoting 797

UNIVERSITY OF NOTTINGHAM

CRIPPS CHAIR OF PRODUCTION ENGINEERING

Applications are invited for election to th Cripps Chair of Production Engineering, whic has recently been established Present salary £1,850 per annum, but salary scale is und review Overseas candidates who are intereste in the appointment and intend to submit a application should notify the Registrar The Un versity of Nottingham, by cable or by airmai The University gives generous assistance towar travelling expenses to those candidates appointe to Professorial Chairs from overseas

It is the intention that applications should, possible be received not later than Tuesda March 1, 1955

H PICKBOURNE,
Registrar

DUBLIN INSTITUTE FOR ADVANCED STUDIES

The Council of the Institute invites applic tions from university graduates whose degr course included mathematics and/or physics f a post as Technical Assistant in the School Theoretical Physics of the Institute Salary £380 per annum, subject to adjustment based cost of living The duties of the post incluc scientific, secretarial and library work The a pointee will be expected to do such scientific a other typing as may be required and to have, addition to the academic qualifications abov mentioned a knowledge of a modern continent language

Applications (in applicant's own handwriting giving full particulars of age, qualifications, et together with copies only of testimonials shou be sent so as to reach the undersigned on before March 31, 1955

PATRICIA O'NEILL,
Senior Clerk

64 Merrion Square,
Dublin

UNIVERSITY OF LIVERPOOL

Applications are invited for the following Fe lowships (i) I C I Research Fellowships Physics, Chemistry, Engineering, Metallurgy a Pharmacology, or any related subject, to whi some appointments may be made during the cu rent academic year The appointments will da from October 1, 1955 The salary will depe upon qualifications and experience but will no mally be within the range £600 to £900 per annu together with F S S U benefits and family allo ances (ii) Two Leverhulme Postgraduate F lowships in the Faculty of Science tenable f one year at a value of £500, renewable for second year at a value of £550

Applications, three copies, stating the Fello ship applied for age, details of qualifications a experience, publications, research work in progr and completed, and an outline of the propos field of research and in the case of the Lev hulme Fellowships, whether National Service quirements have been fulfilled together with names of two referees, should be received later than March 1, 1955 by the undersign from whom further particulars may be obtain (Candidates overseas who find it more conveni to do so may send one copy only by airmail)

STANLEY DUMBELL
Registrar

UNIVERSITY OF LIVERPOOL

Applications are invited for the following p in the Department of Physics (i) Lecturer (Gr II) for which candidates should have had exp ence in either experimental or theoretical nucl physics, (ii) Assistant Lecturer or Lecturer in Subdepartment of Acoustics, at initial sala according to age, qualifications and experie within the ranges current at the time of appo ment for Lecturers and Assistant Lecturers B appointments will commence on October 1, 19

Applications, stating age, academic quali tions and experience, together with the names three referees should be received not later t April 14 1955, by the undersigned, from wh further details may be obtained

STANLEY DUMBELL
Regist

BOROUGH ROAD COLLEGE

ISLEWORTH MIDDLESEX

Applications are invited from men for the of Lecturer in Biology Salary according to Pelham scale of salaries for Training Coll staffs

Full particulars and form of application be obtained from the Principal to whom ap cations must be made by Monday February 2

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston, Berks, requires Optical Technicians Post A (517/WGE/34), to carry out process development on production of extremely accurate optical surfaces in a wide variety of materials The surfaces concerned may not be accessible to normal types of polisher and will not necessarily be plane or spherical Candidates should have had a thorough training in glass polishing to quarter-wave standard and some years experience in the instrument industry Experience of working materials other than glass, particularly metals to extreme precision and an experimental approach to problems are essential Post B (516/WGE/34), to carry out process development on aspheric surfaces and on the production of other precision optical components for instruments of the highest performance Candidates should have had a thorough training in glass polishing to a tenth of a wavelength and some years experience in the instrument industry A thorough knowledge of the present day methods of manufacture and testing of high quality non-spherical surfaces is essential Salary £710 (at age 30) to £830 The successful applicants will be required to join the Authority's principal superannuation scheme which is contributory An initial period of detached duty may have to be served at Fort Halstead, near Sevenoaks, Kent Housing accommodation will be available at Aldermaston within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities During this period, lodging allowance may be payable to suitably qualified candidates —Application forms from Senior Recruitment Officer, A W R E, Aldermaston, Berks Quote reference 517/WGE/34 Post A, or 516/WGE/34 Post B

CENTRAL RESEARCH ESTABLISHMENT ational Coal Board) at Stoke Orchard near heltenham where work is concerned mainly with oduction of smokeless fuels from high volatile als for the domestic market and for metallurgical ocesses require Physicists and Mathematicians ith good honours degrees for superannuable ap- intments in the Physics Department This is gaged in fundamental and other studies in sup- rt of technical processes including mechanical haviour of coal fundamental physics of forma- n of brittle coke from coal in its plastic state ysics of thermal treatment of coal application modern methods of solid state physics to re- arches into structure of coal and problems of id mechanics The Mathematician will work a small section engaged in design and ana- sis of laboratory and small scale plant experi- ents for the whole Establishment Some prac- al experience in work of this kind would be advantage The work is varied and interesting d publication of original work in scientific and hnical journals is encouraged Appointments ll be according to qualifications and experience, Scientist I (scale/range £1 150 by £40 to 350 to £1 550 male), Scientist II (scale £800 by 5 to £1 150 male) or Scientist III (scale £500 £25 to £950 male)—Write giving full parti- lars (in chronological order) of age education alifications and experience (with dates), to tional Coal Board, Central Research Establish- nt Stoke Orchard near Cheltenham Glos, rking envelope TT/928 Original testimonials ould not be forwarded Closing date March 2, 55

BRITISH ELECTRICITY AUTHORITY IN- e applications from senior Biologists for a perannuable post in the Chief Engineer s De- rtment in London The successful applicant ll be required to take charge of a small bio- gical laboratory situated in North London and ll be expected to undertake research and to vise the Authority on the effects of power ation operation upon the life of rivers and other aterways Although the post will be based in ndon, the holder may be required to spend ort periods at any power station in the country connection with specific problems Salary with- N J B Grade II £971 to £1 325 per annum clusive according to qualifications and experi- ce—Applications stating age qualifications, ex- rience and present position and salary to rector of Establishments, Winsley Street, ndon W 1, by February 25, 1955 Quote ref E/568

COMMONWEALTH of AUSTRALIA

DEPARTMENT OF SUPPLY
WEAPONS RESEARCH ESTABLISHMENT
SALISBURY, SOUTH AUSTRALIA
SENIOR SCIENTIFIC OFFICER

Salary £A 1,352 to £A 1,442 per annum Duties To undertake design and development of optical systems for special purpose cameras and optical instruments Qualifications A degree in physics or engineering Experience in the design and development of lenses and in the supervision of small optical workshop Where permanent appointment is accepted the successful applicant will be required to contribute to the Commonwealth superannuation scheme Under specified conditions first-class boat fare (if first-class berth available) of the appointee and his dependants (wife and dependent children), will be paid by the Commonwealth Salisbury is situated sixteen miles from Adelaide, the capital of South Australia

Application forms obtainable from The Senior Representative, (A P 27), Department of Supply, Australia House, Strand, London, W C 2, with whom applications should be lodged by March 3, 1955

UNIVERSITY OF DURHAM

KING'S COLLEGE NEWCASTLE UPON TYNE

DEPARTMENT OF MATHEMATICS

The Council of King's College invite applications for a Lectureship in Applied Mathematics The commencing salary will be determined at a suitable point on the scale £650 by £50 to £1 350, in accordance with the qualifications and experience of the successful candidate Family allowance and F S S U

Further particulars may be obtained from the undersigned to whom applications (twelve copies), together with the names of three referees, should be addressed so as to reach him not later than February 28, 1955

G R HANSON,
Registrar of King's College

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston, Berks, requires Experimental Officers to assist in basic research in inorganic chemistry and metallurgy Minimum qualification is higher school certificate in chemistry or equivalent, but a pass degree in chemistry is desirable Experience in micro-chemical analytical techniques would be an advantage The salary scale is £775 (minimum age 26) to £945 (male) per annum The successful applicants will be required to join the Authority's principal superannuation scheme, which is contributory Housing will be available within a reasonable period for married officers who live outside the Establishment's transport facilities During this period lodging allowance may be payable to suitably qualified candidates —Application form from Senior Recruitment Officer A W R E Aldermaston, Berks Quote Ref 512/WGE/34

DEPARTMENT OF SCIENTIFIC AND INdustrial Research require a Scientific Officer (unestablished) at Low Temperature Research Station Cambridge (after one year's training at Torry Research Station, Aberdeen), for research in refrigeration, processing, and handling of meat First- or second-class honours degree in engineering or equivalent qualification with workshop training or apprenticeship Knowledge of chemistry or refrigeration an advantage Minimum age 21 Prospects of establishment for candidates under 31 Inclusive annual remuneration for 45½-hour week within the range £481 to £870 (men) £481 to £772 (women)—Forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street London S W 1 Quoting Ref C 43/5A Closing date February 26 1955

MATHEMATICIANS REQUIRED AT VARIous Ministry of Supply Research and Development Establishments in Southern England Qualifications First- or second-class honours degree in mathematics preferably with some research experience in an applied field Appointments in Scientific Officer grade Salary range £467 10s to £845 Women somewhat less F S S U benefits may be available Prospects of promotion to Senior Scientific Officer (minimum age 26), within salary range £970 to £1 125 Not established but opportunities to compete for establishment may arise —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K) 26 King Street, London, S W 1, quoting A28/5A

THE UNITED KINGDOM ATOMIC Energy Authority, Foulness, Essex, requires a General Experimental Physicist in the grade of Principal Scientific Officer or Senior Scientific Officer for the investigation of detonation phenomena The field of work comprises classical physics of high pressures and the temperatures as applied to the behaviour of solid high explosives and inert substances in contact with them Minimum qualifications are first- or second-class honours degree in physics and several years' general physical research experience The salary ranges are Principal Scientific Officer, £1,205 to £1 615 (male) per annum, and Senior Scientific Officer £1 040 to £1,205 (male) per annum The successful applicant will be required to join the Authority's principal superannuation scheme, which is contributory —Application form from Senior Recruitment Officer, A W R E, Aldermaston, Berks Quote Ref 528/WGE/34

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston, Berks, requires Scientific Officers for basic research in inorganic and metallurgical chemistry Minimum qualification is first- or second-class honours degree in chemistry, preferably with some research experience of physical chemistry Some knowledge of one of the following is desirable (a) High vacuum techniques as applied to gases and metals (b) Distillation practice and theory (c) Radiochemistry The salary range is £505 to £905 (male) per annum Starting salary will be assessed according to qualifications, age and experience The successful applicants will be required to join the Authority's principal superannuation scheme, which is contributory Housing will be available within a reasonable period for married staff who live outside the radius of the Establishment's transport facilities During this period lodging allowance may be payable to suitable candidates —Application form from Senior Recruitment Officer, A W R E Aldermaston Berks Quote Ref 511/WGE/34

THE UNITED KINGDOM ATOMIC Energy Authority Aldermaston, Berks, requires an Engineer (basic grade) for the engineering of special electronic and light mechanical equipment to meet scientists' requirements, and progressing to final small scale production Applicants should have served a recognized apprenticeship and be corporate members of the Institution of Electrical and Mechanical Engineers, or have exempting qualifications They should have a knowledge of special purposes electronic equipment (such as oscilloscopes employing high speed time bases, pulse generators video amplifiers and stabilized power supply units) A knowledge of the mechanical design problems associated with the manufacture of electronic equipment would be an advantage The salary scale is £695 (linked to age 25) to £1,065 (male) per annum The successful applicant will be required to join the Authority s principal superannuation scheme, which is contributory Housing will be available within a reasonable period for married officers who live outside the Establishment's transport facilities During this period lodging allowance may be payable to suitably qualified candidates —Application form from Senior Recruitment Officer, A W R E, Aldermaston, Berks Quote Ref 510/WG /34

SENIOR SCIENTIFIC OFFICER REQUIRED by United Kingdom Atomic Energy Authority at Sellafield, Cumberland, to undertake metallographic studies, with particular reference to behaviour of materials under irradiation and to welding of rarer metals Qualifications At least second-class honours degree in metallurgy, or equivalent, with three years' postgraduate research experience A wide general experience, particularly in microscopical metallography of ferrous and non-ferrous metals and light alloys is desirable Salary range £1,040 to £1 205 Contributory pension scheme —Applications to UNITED KINGDOM ATOMIC ENERGY AUTHORITY Industrial Group Headquarters P O Box 19, Risley, Warrington, quoting 796

COMMONWEALTH of AUSTRALIA

APPOINTMENT NO 462/69 OF RESEARCH OFFICER

The Commonwealth Scientific and Industrial Research Organization invites applications for appointment to a position of Research Officer (Chemist or Biochemist), Biochemistry Unit, Wool Textile Research Laboratories Melbourne Duties To take part in a programme of research on cellulose-destroying fungi with special reference to the nutritional requirements of particular moulds the nature of the enzymes produced and their mode of action on cellulose Qualifications University honours degree in science, with chemistry, botany or biochemistry as major subjects, and preferably with some research experience in mycology Salary Dependent on qualifications and experience, commencing salary will be determined within the range of Research Officer, £A 1,058 to £A 1 412 per annum actual, thirteen increments with efficiency review at £A 908 and £A 1,064 per annum nominal Salary includes a cost of living adjustment of £A 198 per annum Fare to Australia (including those of wife and family will be paid) The appointment is subject to satisfactory medical examination and the appointee may be granted superannuation privileges

Applications referring to appointment No 462/69, and stating full name, place date and year of birth marital state, nationality, present employment, particulars of qualifications and experience, and of war service if any, accompanied by copies of not more than four testimonials, and names and addresses of two persons willing to act as referees if so required should reach the undersigned not later than March 19, 1955

W IVES
Chief Scientific Liaison Officer
Australian Scientific Liaison Office,
Africa House,
Kingsway London, W C 2

GLASSHOUSE CROPS RESEARCH INSTITUTE

RUSTINGTON, SUSSEX

The Governing Body of the Institute invite applications for the post of Director The Institute, which is carrying on the work of the Experimental Research Station, Cheshunt, is being established on a new site in Sussex, where a large part of the laboratory and glasshouse accommodation has still to be built It is proposed to make the appointment in advance of the retirement of the present Director, so that the selected candidate will as Director-Designate be available to assist in planning the further development of the Institute prior to his assumption of the Directorship Candidates must have high attainments in one of the basic sciences relevant to the work of the Institute and should preferably have experience of horticultural crops The appointment will be in the Deputy Chief Scientific Officer scale £1 950 to £2 125 with superannuation under F S S U, and this scale would for a suitable candidate, be applicable also during the period as Director-Designate The appointment may take effect from October 1, 1955, following a final selection to be made in April or May

Applications to be made before April 15 to the Secretary, Glasshouse Crops Research Institute, Worthing Road Rustington, Littlehampton, Sussex

---

DEPARTMENT OF SCIENTIFIC AND INdustrial Research require Assistant Experimental Officers at the Road Research Laboratory Harmondsworth, Middlesex, as follows Physicist for laboratory research on flow of water in relation to drainage systems (Ref A192/54A), Civil Engineer for field investigation on surface drainage (Ref E31/5/A), Engineer or Physicist for research on soil stabilization (Ref E32/5/A), Engineer or Physicist for full-scale experiments with bituminous materials and for research on bituminous road-making machinery (Ref E33/5/A), Woman to assist head of research section on technical and administration matters and secretarial work in connection with research committees Experience of committee work an advantage (Ref F860/54A) Candidates should be at least 18 and have general certificate of education with two scientific subjects at advanced level or equivalent Pass degree, higher national certificate or equivalent is generally expected if over 22 Inclusive annual remuneration for a 45½-hour week within the following range according to age £304 to £674 (men) £304 to £571 (women) Prospects of establishment for candidates under 28—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street London, S W 1 quoting appropriate reference Closing date February 26, 1955

SOUTHERN RHODESIA FORESTRY COMMISSION

FOREST OFFICERS AND FORESTERS

Foresters Applicants must be British subjects, under 28, preferably single, who hold a Foresters' Certificate Starting salary £462 to £714 per annum, depending on experience on scale, rising to £1,484 per annum Forest Officers Applicants must be British subjects under 30 preferably single, with a degree in forestry (The Chief Commissioner will be prepared to consider applications from men taking finals in June, 1955) Starting salary £624 to £984, depending on qualifications and experience, on scale rising to £1,698 per annum Allowances Marriage £50 per annum, children's £60 per annum, first, £24 per annum, each other dependent child payable in both posts

Application forms and further details from the Secretary, Rhodesia House, 429, Strand, London, W C 2 Completed forms to be returned by February 20

INSTITUTE OF CANCER RESEARCH

ROYAL CANCER HOSPITAL

A vacancy exists for a Chemical Technician in the new Radioisotope Laboratory at the Pollards Wood Research Station, Chalfont St Giles, Bucks Experience in a biological laboratory would be helpful The post is permanent and superannuable, and canteen facilities are available Salary according to age and qualifications

Applications, with names of two referees to be sent to the Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S W 3, marking the envelope "Chemical Technician"

ROTHAMSTED EXPERIMENTAL STATION

HARPENDEN, HERTS

Applications are invited for the post of Head of the Department of Entomology The appointment will be in the Senior Principal Scientific Officer grade (£1,600 by £75(3) by £25 to £1,850) Superannuation F S S U The successful applicant will be required to take up duty on October 1, 1955

Applications, together with names of two persons to whom reference may be made, should reach the Secretary by March 31, 1955

TECHNICIANS FOR NEW ZEALAND DEPARTMENT OF AGRICULTURE

Applications are invited from technicians with experience for work on weedicides at the Invermay Research Station in New Zealand Salary on appointment for applicants with general certificate of education (or equivalent) and six years' experience range from £N Z 555 to £N Z 750, according to experience and qualifications

An appointing officer from New Zealand will interview suitable applicants in London Application forms and general information on conditions of employment may be obtained on request from High Commissioner for New Zealand 415 Strand London W C 2, quoting reference 3/4/40 and mentioning this journal Completed applications to be lodged not later than February 26, 1955

UNIVERSITY OF LONDON

The Senate invite applications for the Readership in Experimental Physics tenable at Queen Mary College (salary £1 300 to £1 500 to £1,700 a year)

Applications (ten copies) must be received not later than March 3, 1955, by the Academic Registrar, University of London, Senate House, W C 1, from whom further particulars should be obtained

---

LONDON TRANSPORT REQUIRE WOMAN Technical Librarian for Director of Research, 55 Broadway Applicants must have previous experience in technical library work, and be either Fellows or Associates of Library Association or possess Diploma of London School of Librarianship, science degree advantageous Salary range £570 to £610 prospects of advancement to £650 Commencing salary according to qualification and experience, medical exam, contributory superannuation scheme after probation, certain free travel facilities—Applications to Staff Officer (F/EV 520), London Transport 55 Broadway S W 1 For acknowledgment enclose addressed envelope

---

READER AND SENIOR LECTURERS OR Lecturers in Physics—The Dean College of Arts and Science, Baghdad, Iraq

---

NEW SOUTH WALES DEPARTMENT OF AGRICULTURE

WAGGA, AUSTRALIA

AGRICULTURAL RESEARCH INSTITUTE

CEREAL TECHNICIAN

Applications are invited for the above position Salary in the range £A 897 to £A 1,067 per annum rising to £A 1,271 per annum, subject to specific conditions Appointee will be responsible for th technical work involved in the assessment c wheat quality including laboratory milling, test on dough quality and experimental bread making Experience in this type of work essential Ap pointee should have the Intermediate B Sc c equivalent qualification Science background a advantage Accommodation for married an single men being erected Appointee will b eligible, subject to medical examination, to contr bute to the State Superannuation Fund Shippin ares to Sydney of appointee and family will b paid

Four copies of applications (together with fou copies of testimonials and other supporting doc ments), should be lodged with the Agent-Gener for New South Wales, 56 Strand, London, W C (from whom further particulars can be obtained by March 14, 1955

UNIVERSITY COLLEGE OF NORTH WALES

BANGOR

Applications are invited for the post of Assi tant Lecturer in Physics The present salai scale, which is now under revision, is £450 b £50 to £550 per annum, and in addition the are F S S U benefits and family allowances Th appointment will date from October 1 1955

Twelve copies of the application should rea the undersigned, from whom further particula may be obtained, not later than March 15, 195

KENNETH LAWRENCE,
Secretary and Registrar

INSTITUTE OF BASIC MEDICAL SCIENCES

ROYAL COLLEGE OF SURGEONS OF ENGLAND

BRITISH POSTGRADUATE MEDICAL FEDERATION (UNIVERSITY OF LONDON

Applications are invited for the full-time po of Senior Lecturer in Biochemistry The su cessful candidate will be expected to take pa in the teaching activities of the Department Physiology Facilities for research are availab both in the laboratories of the Department a the Buckston Browne Farm of the Royal Colle of Surgeons Salary will be within the univers scale of £1 000 by £100 to £1,500 per annu together with membership of the F S S U T commencing salary will be determined by t age qualifications and experience of the success candidate

Applications (three copies), together with t names of two referees should be sent not la than March 5, 1955 to Professor David Slon Department of Physiology, Royal College of S geons of England, Lincoln's Inn Fields, W C from whom further particulars may be obtaine

---

UNIVERSITY OF MANCHESTER

There is a vacancy in the Department Chemistry for an Organic Micro Analyst in t Senior Technician grade Salary at a point the scale £490 per annum to £590 per annu with membership of a superannuation scheme

Applications should be sent to the Chief Te nician, The Department of Chemistry The U versity, Oxford Road, Manchester 13

UNITED BIRMINGHAM HOSPITALS

THE CHILDREN'S HOSPITAL, BIRMINGHAM, 16

Applications are invited from men and wom for the appointment of Biochemist (basic grad Candidates should possess a B Sc degree w honours in biochemistry or chemistry or equi lent qualification Whitley Council salary a conditions of service

Applications, with names of two referees sho be sent to the House Governor as soon possible

---

LECTURER IN MATHEMATICS, WI special interests in either hydro- or aero-dynam or in electromagnetic theory required for Octob 1955 For a suitable applicant the appointm will be in the upper range of the salary sc i e £1 000 and upwards—Applications to H of Department of Mathematics, Imperial Colle London, S W 7

APPOINTMENTS VACANT

ELECTRONICS RESEARCH

ENTHUSIASTIC PHYSICS or ENGINEERING GRADUATES required for interesting RESEARCH on ELECTRONIC CIRCUITS and DEVICES in Research Laboratory situated in pleasant rural surroundings near Reading

Every encouragement for visiting other Laboraories, Conferences, etc, and for publication of original work

EXCELLENT OPPORTUNITIES for ADVANCEMENT within the LABORATORY and he VAST ENGINEERING INDUSTRIAL GROUP it serves

Apply, in writing, to Personnel Officer, Re-earch Laboratory, ASSOCIATED ELECTRICAL NDUSTRIES Ltd, Aldermaston Court, ALDERMASTON, Berks

---

SECRETARY–LIBRARIAN

Young lady, competent shorthand-typist, required as Secretary to Research Department engaged in nutrition research and also to be responsible for the departmental library Some knowledge of science is essential and some ibrary experience would be an advantage Five-day week, starting salary £400 to £500 per annum according to experience

Apply in writing, giving age and full details of previous experience, to Research Department, Bovril Limited 148 Old Street, E C 1

ARTHUR GUINNESS, SON & CO (DUB-in) Ltd have a vacancy for a Chemist in their Brewing Research Laboratory, Dublin, to work on general analytical and brewing research problems Candidates should possess a good honours degree in chemistry, and some post-raduate experience Salary according to qualifications and experience There is a non-contributory pension scheme and other benefits — Applications giving full details of qualifications and experience should be addressed to the Chief Chemist, Arthur Guinness Son & Co (Dublin), td, St James's Gate, Dublin

---

ARTHUR GUINNESS, SON & CO (DUB-in) Ltd require a Chemist or Biochemist for heir Brewing Research Laboratory in Dublin The post will be a responsible one and will offer ample scope and prospects to one interested in biochemical research work Candidates should e under thirty years of age and possess a good onours degree in chemistry or biochemistry and ostgraduate experience in research work Know-dge of enzymology would be an advantage A ood salary will be offered and there is a non-ontributory pension scheme, and other benefits Applications giving full details of qualifica-ons and experience should be addressed to the Chief Chemist Arthur Guinness, Son & Co Dublin) Ltd, St James's Gate Dublin

---

MAY & BAKER LTD, DAGENHAM, sex, have a vacancy for a young graduate in eir Biological Control Department The post volves mainly biological standardization of emotherapeutic substances —Apply initially, in iting stating age and qualifications, to the rsonnel Officer, quoting reference No 69

ENGLISH CLAYS LOVERING POCHIN & Ltd St Austell, Cornwall, have vacancies the Research Department for (1) an Inorganic emist with postgraduate experience, (2) a aduate Physical Chemist —Application in con-ence to the Research Manager

---

IMPERIAL CHEMICAL INDUSTRIES, LTD, astics Division has two vacancies for Process vestigation Officers The work is that of in-stigation and development of processes operated the manufacturing plants One vacancy occurs a factory in Lancashire and the other at tories on Tees-side Candidates should have good honours degree in chemistry, post-aduate research experience at a university uld be an advantage but is not essential The nbination of experience in the fields of process earch and chemical plant operation would be ticularly useful The desirable age range is (if exempt from National Service) to 30 years age —Applicants are requested to send full ails of their education and experience to the ff Manager I C I Limited Plastics Division ck Fan Road Welwyn Garden City, Herts d to quote reference number N/1

THE EDISON SWAN ELECTRIC CO, Ltd, Cosmos Works, Brimsdown, Enfield, Middlesex, has vacancies in its Research and Development Departments for

1 Development Engineers for work on design and development of thermionic valves
2 Technical Assistants for work in connection with design and development of thermionic valves
3 Mechanical Engineers interested in the problems of mass production associated with thermionic valves

These vacancies are the result of a rapid expansion in the Company's activities The positions are progressive and carry the advantages of a pension scheme

Applicants for vacancies (1) should have an engineering or physics degree but applications from candidates with H N C or equivalent will be considered

Applicants for vacancies (2) and (3) should have ordinary N C or H N C or Inter B Sc or equivalent

The starting salary will be in accordance with the qualifications, experience and age of the applicants

Applications should be in writing and will be treated with the strictest confidence

Apply to the Personnel Superintendent

CHIEF CHEMIST WM MOORHOUSE & Sons Ltd, Sunglow Model Factory, Leeds, require Chief Chemist experienced in Preserves or Food Industry, able to take full analytical and quality control Main specialities Jams, marmalades lemon curd, Christmas puddings mincemeat bottled and canned fruits, jellies This is a senior appointment and carries non-contributory pension —Apply, giving full details present appointment, past record, salary required etc, to Managing Director All applications treated in strictest confidence

---

MONKHOUSE AND GLASSCOCK, LTD Snowsfields London, S E 1, manufacturers of "Monk and Glass" food products, have a vacancy for a chemist, preferably not more than 30 years of age A good degree and experience with foodstuffs are required The successful candidate will be in immediate charge of control and development work under the Chief Chemist The initial salary will depend on qualifications and experience There is a staff pension scheme — Applications, giving full details of career, etc should be addressed to the Chief Chemist

---

GRADUATE CHEMIST OR ENGINEER REquired by Research Association, to apply in members' factories results of research Position suitable young man recently qualified or some experience Good starting salary, excellent prospects Pension scheme —Write particulars training experience to Director British Launderers Research Association The Laboratories, Hill View Gardens, Hendon N W 4

AFRICAN EXPLOSIVES AND CHEMICAL Industries Limited, South Africa, has a limited number of vacancies in its Research Department near Johannesburg for Physical Chemists who have recently graduated with at least honours degree Remuneration will depend upon qualifications —Inquiries should be addressed to Mr R A Webb, African Explosives and Chemical Industries Limited, Imperial Chemical House Millbank London S W 1

SENIOR AND JUNIOR RESEARCH PHYSICISTS, preferably with university or industrial research experience are required to undertake basic research work of thermionic emission and related aspects of surface physics Wide scope and good prospects for men with initiative — Applicants should write to the Manager, Research Department Metropolitan-Vickers Electrical Co Ltd Trafford Park Manchester 17, giving particulars of their age qualifications and experience and suitable references

---

JOSEPH LUCAS LIMITED HAVE AN INTERESTING vacancy in their research and development laboratories which would be suitable for a young graduate with honours degree in mathematics or physics The work is largely of a fundamental nature and is concerned with acoustics and mechanical vibrations Previous industrial experience is not necessary —Please reply giving qualifications age and any other relevant details to Personnel Manager Joseph Lucas (Electrical) Ltd Great King Street, Birmingham quoting reference PM/D/59

DUNLOP RUBBER CO, LTD

The following appointments are offered at the Research Centre, Birmingham

PHYSICIST with good honours degree, is required for a post which offers scope both for the development of factory instruments and for fundamental studies in rubber physics Applications from students who expect to graduate next summer will be considered J M 54

OPERATIONAL RESEARCH GRADUATE required to conduct operational research work in rubber and plastics industry The work will be based on a research laboratory with facilities for statistical and computational work and full modern techniques for investigational work The applicant should either have previous experience in this work or combined laboratory and factory experience J M 55

PHYSICISTS required for fundamental textile research work Applicants should have good honours degree Textile experience is not essential Applications from students who expect to graduate next summer will be considered J M 56

Applications for above positions should be made in writing quoting given references and details of age, qualifications and experience to Personnel Manager, Dunlop Rubber Co, Ltd, Fort Dunlop Erdington, Birmingham 24

MULLARD RESEARCH LABORATORIES

invite applications for two types of permanent positions in its Vacuum Physics Laboratory In both cases the work involves research and development in the realm of semi-conductors, solid state physics and photo devices

(a) SENIOR PHYSICISTS to act as Group Leaders with several years of academic or industrial research experience, preferably but not necessarily, in the above fields

(b) PHYSICISTS with honours degrees, to work in research and development teams—with or without previous experience

In both cases, the positions offered are progressive and pensionable, and carry attractive salaries Candidates, free of national service obligations, should apply, quoting reference V P L (J),
to Mr G A Taylor,
Personnel Manager,
Mullard Research Laboratories,
Cross Oak Lane,
Salfords, near Redhill, Surrey

RESEARCH ENGINEERS HONOURS graduates preferably with some postgraduate or industrial research experience capable of planning and controlling research work on a wide range of mechanical engineering problems including materials structures, mechanisms and heat transfer Wide scope and good prospects for men with initiative Age 25 to 30 approximately —Applicants should write to Manager, Research Department, Metropolitan-Vickers Electrical Co Ltd, Trafford Park Manchester 17 giving a statement of their age qualifications and experience and suitable references

---

DENIS FERRANTI METERS LIMITED Bangor North Wales Attractive vacancies occur in company situated in North Wales coastal town for engineers and physicists to work on interesting development projects Experience on optical devices, electro-magnetic equipment or electronic instrumentation, and degree or higher national certificate desirable A vacancy also exists for an industrial statistician to plan experiments and interpret data obtained in research work Assistance may be given in obtaining accommodation Good prospects in rapidly expanding organization —Applications in confidence to Chief Engineer

THE EDISON SWAN ELECTRIC CO, Ltd, Cosmos Works, Brimsdown, Enfield, Middlesex, has vacancies in its Research and Development Laboratories for

1 Circuit Development and Application Engineers for colour television investigations

2 Circuit Development and Application Engineers for black and white television development work

3 Engineers for development work on television and F M amplifier problems Previous experience in V H F or F M required

4 Cathode Ray Tube Development Engineers for development work on colour and black and white tubes Previous experience on cathode ray tube development or design required

[illegible]plication Engineers for work in connection with customer problems on television, radio and F M

6 Engineer for design of test equipment for colour, black and white television and allied development work

7 Engineers for circuit development and application work on transistors

The above applicants should have a good engineering or physics degree or equivalent, but vacancies also exist for candidates with H N C or equivalent qualifications

The vacancies are a result of a large expansion in the Company's activities

Good salaries will be paid to suitable applicants, and the positions are progressive and carry the advantages of a pension scheme

The starting salary will depend on the qualifications, experience and age of the applicants

Applications in writing, which will be treated with the strictest confidence, should be sent to the Personnel Superintendent

RESEARCH PHYSICIST

The British Jute Trade Research Association has a vacancy for a Physicist to assist in research into the fundamental principles underlying the processing of textile fibres into yarns the work primarily involves classical physics, and applicants should possess a good honours degree The commencing salary will be fixed in accordance with the qualifications and experience of the person selected and F S S U provision will be available

Write, giving full details to the Secretary, The British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee

---

ASSISTANT WITH TECHNICAL QUALIFications required by Metropolitan-Vickers Electrical Co Ltd, Trafford Park, Manchester, 17, to train as Industrial Information Officer Experience of this type of work is not essential Salary will depend on qualifications and experience and will be progressive —Write, giving full particulars, including age sex, nationality education and experience to Personnel Manager marking envelope "H 2"

ABSTRACTOR REQUIRED FOR ENGINeering and physics subjects by Metropolitan-Vickers Electrical Co Ltd Trafford Park, Manchester 17 Progressive opportunities for one who has ability for concise expression, is interested in new developments and in writing up technical matter Engineering experience would be an advantage initially, but experience in abstracting not essential —Apply, in writing to Personnel Manager giving details of technical qualifications, experience if any and present salary Mark envelope "F 1"

MATHEMATICIAN (GRADUATE) IS REquired for the solution of problems arising in new applications of diesel engine injection equipment The work involves the use and refinement of a digital computer programme Industrial mathematical experience is desirable National Service must be over Salary according to qualifications and experience Pension scheme —Apply in writing to the Personnel Manager Ref R 16, C A V Limited, Warple Way, Acton W 3

COMPANY ON SURREY BORDERS OF London engaged in packaging industry require Research Engineer Physicist preferably but chemical experience useful Knowledge of paper converting would be advantageous but not essential —Apply in writing to Box N 832 c/o 191, Gresham House, E C 2

UNICAM INSTRUMENTS, LTD

Applications are invited from electronic engineers for positions in the development and inspection departments of Unicam Instruments of Cambridge This company is engaged in the manufacture of important instruments, combining original optical and electronic design, which are much in demand for academic and industrial research and process control the world over Good salaries according to qualifications will be paid —Applicants should send full details of age, education and experience, to the Personnel Manager, Unicam Instruments Ltd, Arbury Works, Cambridge

MECHANICAL AND CHEMICAL ENGINEERS

Courtaulds, Limited Chemicals Division, requires two graduate Mechanical Engineers and one Chemical Engineer for investigational and development work near Manchester The work is of an original nature in connexion with the development of chemical plants and processes for which a real interest in and potential talent for engineering development work as applied to large-scale chemical plant is of paramount importance The Mechanical Engineers must have served an apprenticeship for at least two years, and all candidates must have had practical works experience Honours degree men preferred Age 25 to 35

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds, Limited, 16 St Martin's-le-Grand, London, E C 1, quoting the reference number H8 for Mechanical Engineers and H 9 for the Chemical Engineer

---

CHIEF CHEMIST REQUIRED BY FIRM specializing in the rare metals to supervise both routine and research laboratories Ph D or equivalent degree with some industrial experience Commencing salary £1,500 per annum Contributory pension scheme —Box 636 T G Scott and Son, Ltd, 143-147 Regent Street, London W 1

RESEARCH LABORATORIES OF A MAJOR oil company have a vacancy for a first-class electronics engineer The position, which is a new one, involves the establishment of maintenance procedures for modern analytical instruments and the design and application of control instruments for pilot plant, test engines and analytical work Applications for this position are invited from first- or upper second-class honours graduates in physics, chemical or electrical engineering who have had a minimum of five years' experience in the application of electronics to industrial and/or laboratory instrumentation The salary offered will to some extent be dependent on the qualifications of the successful candidate, but it will be at a level commensurate with the responsibilities of the job The position is permanent and pensionable —Write in first instance to Box 643 T G Scott and Son, Ltd, 143-147 Regent Street London, W 1, giving brief details of education and experience

---

GRADUATE CHEMIST, METALLURGIST or Chemical Engineer required, to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel —Apply Electro-Chemical Engineering Co, Ltd, 161 Queens Road, Weybridge Surrey

---

CHEMISTS AND PHYSICISTS REQUIRED for the preparation and evaluation of luminescent materials for use in a new project Men of graduate standing with relevant experience are needed Salary in accordance with qualifications Location near Northampton —Box 641, T G Scott and Son Ltd 143-147 Regent Street, London W 1

JUNIOR TECHNICAL ASSISTANT REquired by London Chartered Patent Agents with a view to training for qualifying as a patent agent Degree standard in electrical or mechanical engineering —Write, giving details of age, experience etc, to Box No 5952 c/o White's Ltd, 72/78, Fleet Street, E C 4

IMPERIAL CHEMICAL INDUSTRIES, LTD, Lime Division has vacancies for Research Chemists (age range 26-35) Candidates should have a Ph D, M Sc, or at least an honours degree in physical and inorganic chemistry —Apply giving full particulars to the Division Staff Officer, Royal Exchange Buxton

---

LADY CHEMIST, GRADUATE OR H N C required for analysis of electroplating and allied solutions —Apply, Electro-Chemical Engineering Co, Ltd, 161 Queens Road Weybridge Surrey

COTTAGE LABORATORIES LIMITED

have a number of vacancies for scientific and engineering appointments at both senior and junior levels, to undertake interesting and original development work Applicants should possess experience in at least one of the following subjects

Light Mechanical Engineering
Electromechanical Servo Systems
Electronic Circuit Design

and for some of the posts a knowledge of physics would be an advantage Candidates for the senior grades will, in addition, be expected to hold adequate qualifications in the appropriate subjects The appointments will carry salaries commensurate with the duties and responsibilities involved, and are pensionable after one year's satisfactory service

Excellent opportunities for progressive positions in an expanding organization are available to those with real ability and initiative

Five-day week, with good holidays and sick pay The laboratories are fully provided with modern equipment and are situated in pleasant country surroundings on the main Portsmouth Road with good public transport services from Guildford and Kingston passing the premises

First-class canteen, sports club and recreational facilities

All applications should be addressed to the Technical Manager at Portsmouth Road Cobham, Surrey, giving full details o qualifications, previous experience anc salary required, and will be dealt with ji strictest confidence

---

THE BRITISH PETROLEUM COMPA
have vacancies in their Production Research
Development Establishment at Kirklington
in the Nottingham area, for Honours Gradu
trained in physics and/or chemistry, and pre
ably, but not essentially, with two or three ye
experience in industry The work is concer
with problems which arise in the exploitation
oil reservoirs The properties of reservoir ro
including pore, surface and electrical cha
teristics and of the fluids they contain, are stu
to determine the factors which influence flow
oil gas and water underground, this infor
tion is applied in studying the behaviour
individual producing fields with special refere
to recovery efficiency Supporting investigat
cover borehole surveying comprising the la
forms of electrical and radioactivity loggi
modern high pressure techniques are used in
serving the phase behaviour of the fluids u
reservoir conditions Interpretation of ex
mental and field data calls for some mathema
ability Opportunities arise for staff to follow
investigations in the field, consequently ca
dates should be prepared to work abroad as
when the need arises Age under 30 ye
Good pension scheme Salary according to
and experience —Write, stating age and full
tails of qualifications, quoting H 3129, to
7273, c/o 191 Gresham House, E C 2

BOOTS PURE DRUG CO LTD HAV
vacancy in the Pharmacology Division of
Research Department for a young gradu
preferably with some research experience
successful applicant will be engaged in pharm
logical and toxicological investigations Sa
in accordance with qualifications and experienc
Applications to Personnel Manager, Station St
Nottingham

STATISTICIAN REQUIRED FOR OPE
tional Research into production control probl
of a large steelworks in the Sheffield area
work involves variance analysis, etc, of mac
behaviour, set in the study of stochastic proce
of flow A knowledge of queue theory is des
and the ability to handle time series inclu
auto-correlation The applicant should be in
ested in the Monte Carlo treatment of synth
data and in such economic developments as g
theory, activity analysis and linear programm
He/she will probably hold, or be about to g
a degree in mathematical statistics, and sh
apply in fullest detail (referring to breadth
interests and stating salary expected) to the
duction Control Officer, Box 629, T G Scott
Son, Ltd, 143-147 Regent Street, London, W

THE SHELL PETROLEUM COMPANY, Limited has following openings at their Re-earch Centre Thornton-le-Moors, Cheshire, for A) Organic Chemists, positions involving applica-ional work on the Company's products, and will oncern studies in the fields of organic synthesis, ydrocarbon analysis or general oil chemistry Candidates should possess good honours degree or quivalent (B) Physical or Organic Chemists, referably with postgraduate research experience nd an interest in mass spectrometry The work s concerned with application of a mass spectro-eter to research on gaseous, volatile and higher oiling hydrocarbons A working knowledge of lectronics and mathematics, including the use of alculating machines, is essential, and general iterest in the use of fuels and lubricants would e an additional advantage Starting salary ac-ording to qualifications and experience Attrac-ve pension benefits —Apply in writing, giving ge full details of experience and qualifications lso whether applying for (A) or (B), to Staff Department R/2, Shell Petroleum Company, imited, St Helen's Court London E C 3

SEVERAL WELL QUALIFIED INORGANIC r Physical Chemists wanted for a special group the research organization of a major chemical ompany Men are required with high technical itiative and sound knowledge who are interested original development work in inorganic and rgano-metal fields At least one of the appoint-ents will carry a salary of up to £1,500 per nnum —Applications are invited, giving com-rehensive information as to age background and perience, to Box 646, T G Scott and Son, Ltd, 43-147 Regent Street, London, W 1

BRITISH CELLOPHANE, LTD, BRIDG-ater, Somerset, invites applications for the fol-wing posts Research Chemist Male graduate, ge 20 to 40 The post is concerned with the lection of compounds for milling and calander-g of polymers for plastic films Please quote ef No R37 N Research Physicist Male aduate, age 20 to 40 The duties involved will e laboratory experimental work on the properties nd uses of packaging films Please quote Ref o R38 N There is a contributory pension ind scheme —Five-day week —Applications ould be addressed to the Personnel Officer, stat-g qualifications, experience and salary required, d quoting appropriate reference number

Advertisers please note You must add "Apply Employment Exchange" unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

PETROLEUM COMPANY REQUIRES TECHnical personnel having first-class qualifications for the following posts in its U K research department in the environs of London 1 Industrial Chemist or Chemical Engineer, aged 30 or over, with considerable plant experience, preferably in the petroleum industry, and interested in design and operation 2 Young Physicist or Physical Chemist of initiative and zest and sound knowledge of mathematics 3 Young Graduate Chemist, with first- or second-class honours in chemistry and interested in organic chemistry The intention is to offer attractive remuneration to the fullest extent justified by ability, qualifications and experience, there is a generous non-contributory pension scheme —Applications, giving full details and stating salary required to be addressed to Box N 823 c/o 191 Gresham House, E.C 2

THE BRITISH LEATHER MANUFACturers' Research Association has the following vacancies (1) Graduate with experience of research on dyeing or dyestuffs with a knowledge of the technology of dyeing either leather or textiles (P S O) (2) Graduate (physical or organic) to work on leather dyeing (S O) (3) Graduate (inorganic or physical) with research experience, to work on fundamental aspects of chrome tanning (S S O) (4) Graduate with research experience to work on the measurements of the physical and mechanical properties of leather (S S O) Starting salaries dependent on age, qualifications and experience S O, £450 by £25, S S O, £600 by £50, P S O £1,000 by £50 to £1,350 Benefits under F S S U —Applications to Director of Research B L M R A, Milton Park, Egham, Surrey

APPLICATIONS ARE INVITED FROM young Physicists possessing honours degree for work on the development of transistors Postgraduate work on semi-conductors and solid state physics would be an added qualification Laboratories in ideal country surroundings —Applications to Personnel Manager, Standard Telephones and Cables Ltd, Ilminster

SENIOR PHYSICIST WANTED BY FACtory on the Surrey Borders of London engaged in packaging —Apply, in writing, stating age, experience, etc, to Box N 831, c/o 191, Gresham House, E C 2

APPOINTMENTS WANTED

PH D, MALE, EMPLOYED ABROAD, UNable to rejoin post until summer, desires temporary position, preferably with research team, in non-industrial region Experience in microbiology, carbohydrates and other organics Publications Reads several languages Suggestions welcomed —Box 644, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

GRANTS & SCHOLARSHIPS

ROYAL HOLLOWAY COLLEGE
(UNIVERSITY OF LONDON)
POSTGRADUATE STUDENTSHIPS [illegible]

Studentships of £40 eligible for supplementation by the Ministry of Education are offered for the Session 1955-56 with the possibility of renewal for a second year, to men and women who are graduates (in arts or science) of any university Studentships of £60 eligible for supplementation by the Ministry of Education are offered for the Session 1955-56, with the possibility of renewal for a second year, to women who are graduates (in arts or science) of any university Particulars may be obtained from the Registrar

Applications should be forwarded to the Principal, Royal Holloway College, Englefield Green, Surrey, not later than June 7, 1955 The awards will be made in the latter part of July, 1955

MISCELLANEOUS

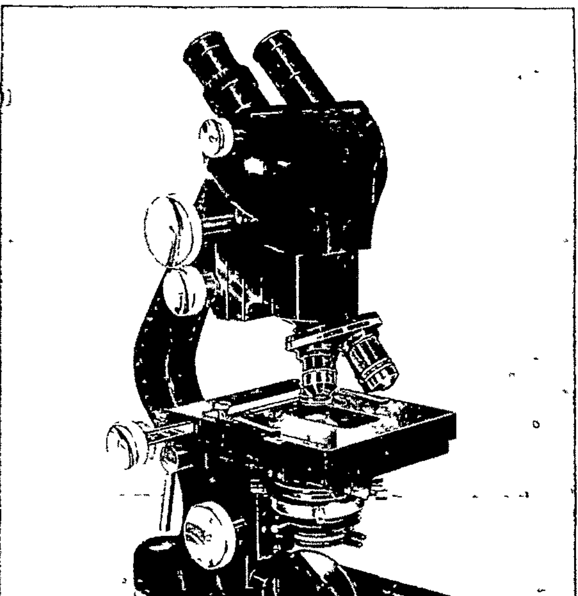
ELECTRONICS APPLIED TO INDUSTRY Learn the basic principles and applications with our modern self-study course Experimental work included if required —Free Brochure from E M I Institutes Dept N 56, London, W 4 (Associated with H M V)

TRANSLATIONS FROM GERMAN AND French of scientific and technical matter Competently carried out —Box 645 T G Scott and Son, Ltd 143-147 Regent Street London W 1

THE "BACTIL" BINOCULAR MICROSCOPE

The ideal form of binocular microscope using objectives of all powers. It can be selected with either a Flat Top or a Circular Rotating Mechanical Stage.

Write for List 1A



WATSON'S

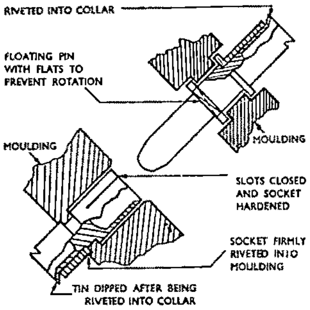
W. WATSON & SONS LTD. 313 HIGH HOLBORN, LONDON, W.C.1

"UNITORS"

Inter-unit connectors for 4 to 25 contacts

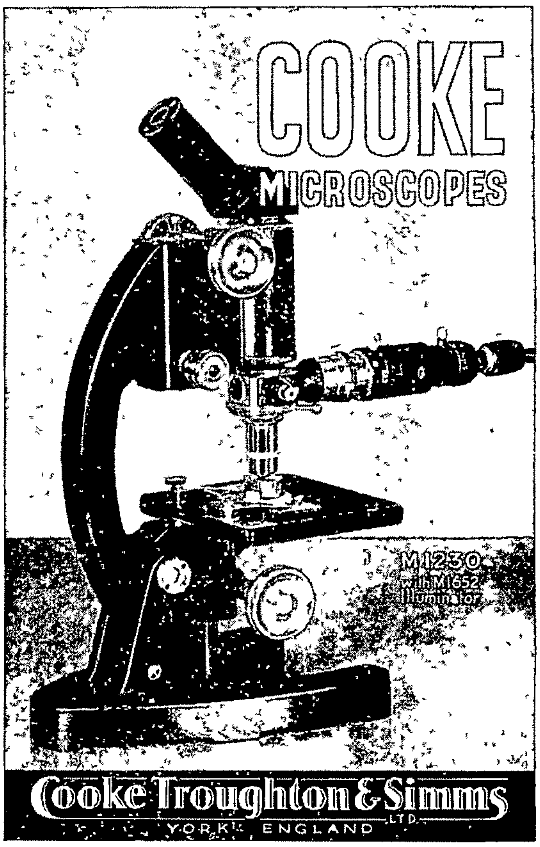
LIST No	PINS	BODY SIZE
L 653/ P&S	4	1 7/16" x 13/32"
L 654/ P&S	8	1 31/64" x 37/64"
L 655/ P&S	12	1½" x 27/32"
L 656/ P&S	18	2" x 27/32"
L 657/ P&S	25	1½" x 1 3/16"

Working volts 500 v Peak, pin to pin


RIVETED INTO COLLAR
FLOATING PIN WITH FLATS TO PREVENT ROTATION
MOULDING
MOULDING
SLOTS CLOSED AND SOCKET HARDENED
SOCKET FIRMLY RIVETED INTO MOULDING
TIN DIPPED AFTER BEING RIVETED INTO COLLAR

Unitors facilitate the uncoupling of sub-assemblies for servicing or replacement Each consists of a block of plugs and one of sockets, arranged so as to be non-reversible Pins are of high grade brass silver-plated, sockets of differentially hardened beryllium copper Normal pins carry 3 amp, but each block has two larger pins carrying 10 amp each

BELLING & LEE LTD
GREAT CAMBRIDGE RD., ENFIELD, MIDDX., ENGLAND



ZEISS WINKEL

BINOCULAR MICROSCOPE

with intense illumination for manipulation and operation

The well known Stereomicroscope, with its long, fixed working distance and rotary change of magnification, has been fitted with a co-axial illuminating system, mounted upon a balanced stand, and applied to several branches of medical work A photographic attachment is also available

Its advantages in use merit consideration for many branches of biology

RAYNER
100 NEW BOND STREET, LONDON, W 1
Telephone GRO 5081

SINGER

Micromanipulators

Singer (High-power) Micromanipulators are suitable for use under magnifications of from × 100 to × 1,000 diameters *plus*, as described by Barer and Saunders-Singer in the *Quarterly Journal of Microscopical Science*, Vol 89, pp 439-447, December, 1948

Singer Microdissectors (Low-power Micromanipulators) are suitable for use under magnifications of from 1 to ×200 diameters and are described by Barer and Saunders-Singer in the *Journal of Scientific Instruments*, Vol 28, pp 65-68, March 1951.

●

SINGER INSTRUMENT COMPANY LTD.
83, London Street, Reading

GLASSWORKERS' STRAIN-VIEWING POLARISCOPE

Full wave retardation analyser for 5800 A gives most sensitive colour indication of strain Field and sight aperture 1½" dia Dimensions 6½" × 5½" × 5" Price £11 16s 6d

As above but without colour analyser showing strains against black field Price £4 15s. 0d.

Immediate Delivery

H. S. B. MEAKIN, LTD., 36, Victoria Street, S.W.1

SUPPLIERS OF POLAROID PLASTIC and GLASS Tel : Abbey 6713

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE

FROM LIVER OR YEAST

and other SIGMA brand products are now available
Ask for list SIGMA 8.

GEORGE T. GURR LTD.
136-138 NEW KINGS RD, LONDON, S W 6
The Microscopical Stain People

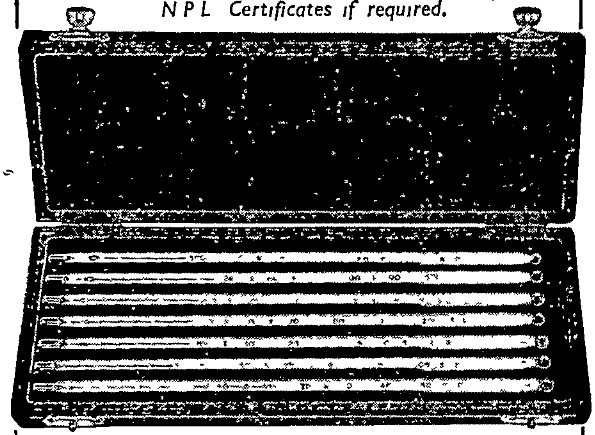
◄ ◄ ◄ ◄ **GRATICULES**

We are now using so many modern methods of processing scales, masks and other graticules on glass that we can find a solution to most glass engraving and printing problems

PATON HAWKSLEY
ROCKHILL LABORATORIES, KEYNSHAM, SOMERSET
Offices 389 Archway Rd, London, N 6 KEYNSHAM 2364

Thermometers . . .
hydrometers . . .
SCIENTIFIC INSTRUMENTS

Made to IP, BSS, STCPT & ASTM specifications NPL Certificates if required.



Set of Short Range, Short Stem thermometers made to B.S 1365 1951 In morocco leather case

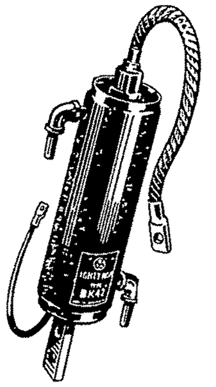
Phone *Liberty* *2283-6* EST. ZECOL 1888 *Telegrams Zealdom, Souphone, London*

G. H. ZEAL LTD.
LOMBARD RD, MERTON, LONDON, S.W.19

B T-H

IGNITRONS

— HIGH-SPEED HEAVY-CURRENT ELECTRONIC "CONTACTORS"



A complete range for use in Electric Resistance Welding Equipment

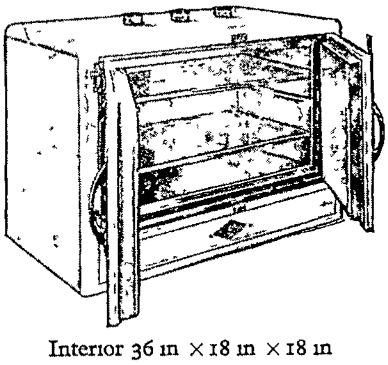
Interchangeable with American Ignitrons sizes A. B. C. D without modification to your equipment.

THE
BRITISH THOMSON-HOUSTON
COMPANY LIMITED, RUGBY, ENGLAND
Member of the AEI group of companies

A4606

LTE "CUSTOM BUILT"

Hot Air Oven and Steriliser



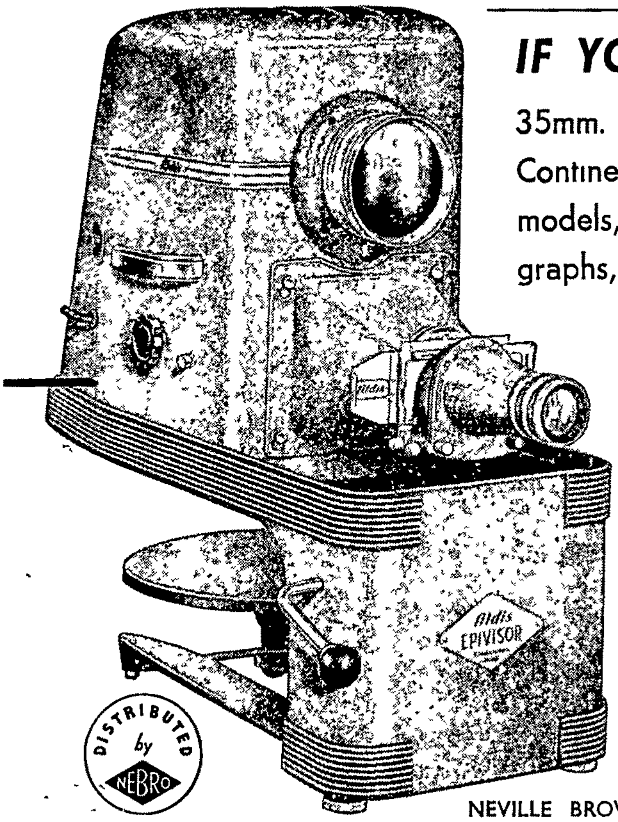
Interior 36 in × 18 in × 18 in

Also stocked in 3 standard sizes which are available for one month on test approval .

Illustration on request to

Other LTE Products—
- *Incubators*
- *Universal Baths*
- *Soxhlet Heaters*
- *Thermostatic Baths*
- *Dyepot Baths*
- *Brewer's Mash Baths*
- *"PATRA" Humidity Cabinet*

LABORATORY THERMAL EQUIPMENT LTD
GREENFIELD, NR OLDHAM, ENGLAND
Telephone Saddleworth 552



IF YOU WANT TO PROJECT

35mm. film strips, 2"x2" or 3¼"x3¼" slides, Continental slides, micro slides, specimens, models, drawings, blueprints, photographs, graphs, etc., etc. . . .

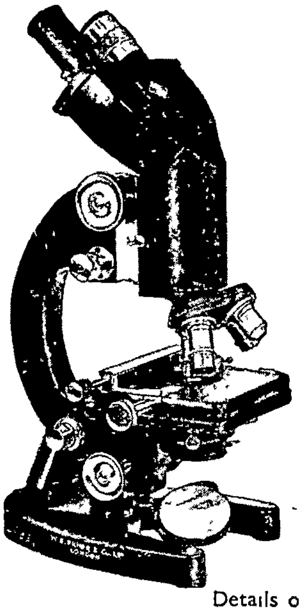
THERE IS ONLY ONE ANSWER

Aldis 'EPIVISOR'
(Registered Trade Mark)
EPIDIASCOPE

This versatile instrument enables you to project greatly enlarged and perfectly defined images of flat and solid objects, as well as film strips and slides It is indispensable in research and in training Full details will gladly be sent on request, together with the name of your nearest dealer, who will be pleased to demonstrate.

Sole Wholesale Distributors.
NEVILLE BROWN & CO LTD, 77 NEWMAN ST., LONDON, W.1

The Hall-mark of a PRIOR *Precision-built Microscope*



THE
PRIOR
"UNIVERSAL" BINOCULAR MICROSCOPE

A precision instrument made by Specialists for Specialists.

*

Available with Vertical Binocular and Monocular Bodies
Flat Top or Circular rotating mechanical stage
Standard Objectives and Eyepieces of all powers

*

Details on Request

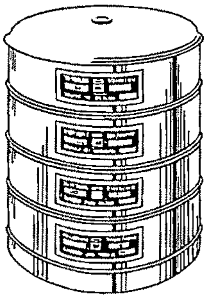
W. R. PRIOR & CO. LTD.
NORTHGATE END BISHOP'S STORTFORD
HERTFORDSHIRE

ENDECOTT'S

Standard Test Sieves

for Accuracy!

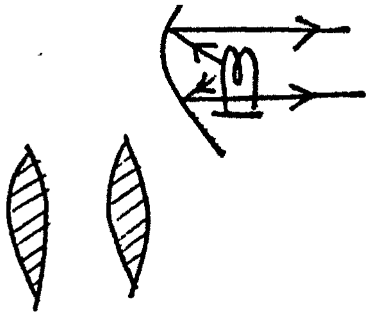
To B S S or American Standards



Accurate sampling or testing is essential and Endecott's Test Sieves are *guaranteed* to conform to specification The patent sieve body contains no crevices or blind spots to impair test efficiency Durability is assured by attachment of the wirecloth direct to sieve frame, giving uniform tautness and long life Standard sizes are available *from stock*, special requirements can be satisfied promptly

X Test Sieve Vibrators
Pocket Interchanger Sieves
Write for literature X

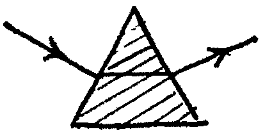
ENDECOTT'S (FILTERS) LTD
251, Kingston Road, London, S W 19 Liberty 8121/2



For radiation measurements

- *ultraviolet*
- *visible*
- *infrared*

BUILDING BLOCKS

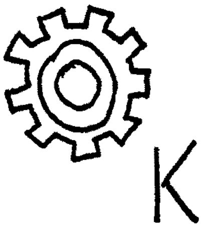


If you have a problem in radiation measurement, there is a Building Block combination to help you Building Blocks are unitized components, covering a wide spectral range, that can be assembled into an infinite number of combinations, each designed to meet particular problems.

For example, with standard Perkin-Elmer parts it is possible to construct universal spectrometers covering the visible, ultra-violet and infrared regions; micro-spectrophotometers, high resolution grating spectrometers, Rapid Scan Monochromators, Raman, and many other instruments utilizing monochromatic radiation

Write us your problem in radiation measurements—or choose your building blocks from the list below.

The Perkin-Elmer Corporation, 890 Main Avenue, Norwalk, Conn.



Standard Building Blocks

Sources

Hydrogen lamp (2100 Å—3600 Å) and Power Supply
Tungsten Ribbon Filament (0 350 micron—2 7 microns) and Power Supply
Globar (1 micron—40 microns) and Power Supply

Source Focusing Assemblies

Single Beam Globar Source Assembly
Multiple Source Assembly
General purpose source assembly
Direct ratio twin beam source assembly

Monochromators (Prism or Grating)

Model 99 double pass
Model 83 single pass

Detectors

Photomultiplier Tube (2100 Å—7000 Å)
Lead Sulfide Cell (0 4 micron—2 7 microns)
High speed thermocouple (1 micron—40 microns)

Detector and Exit Optics

External PbS and Thermocouple Mount
External Photomultiplier Mount
Internal Photomultiplier Mount
Cassegrain Condensing System
General purpose exit optics assembly

Amplifiers

Thermocouple Preamplifier
Photocell Preamplifier
Model 81-A 13 cps Amplifier
External 13 cps chopper and rectifier assembly

Automatic Operation

Wavelength drive and control system
Electronic Servo Slit programming system
String slit drive

Miscellaneous Accessories

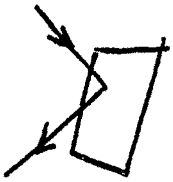
Infrared Polarizer and Rotable Cell Mount
Specular Reflectance Attachment
Infrared Microscope Attachment

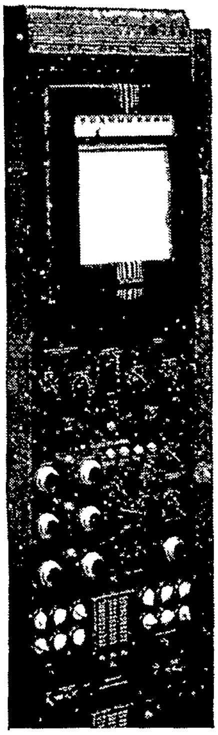
Mirrors and Mounts

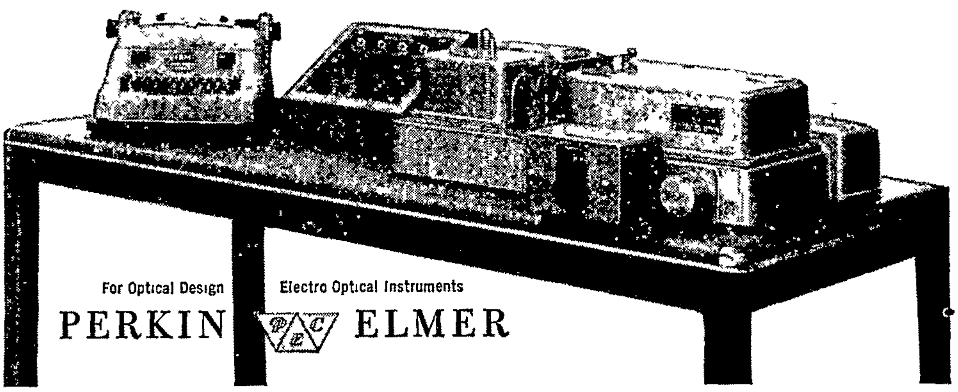
Standard Spectrometers Mirrors and Mounts
Off axis paraboloids (14°, 18° and 21°)

Special Sampling Accessories

Adjustable long path gas cell (10 meters)
Horizontal cell mount with heated stage and power supply
High pressure cells
Evacuable KBr pellet die
Microcells





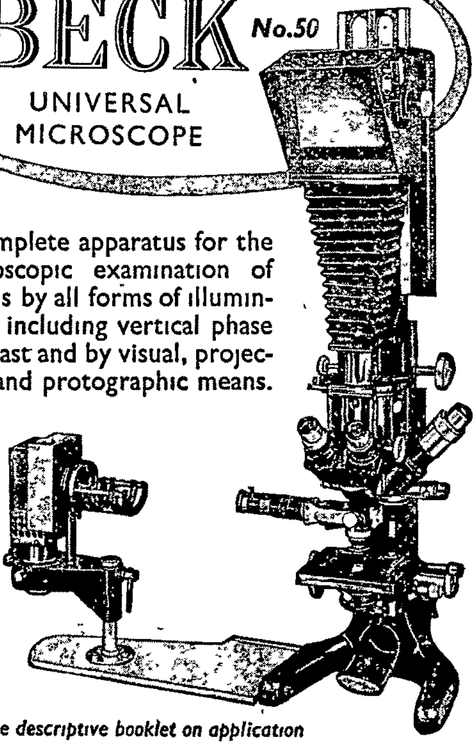


For Optical Design Electro Optical Instruments

PERKIN ELMER

BECK No.50
UNIVERSAL
MICROSCOPE

A complete apparatus for the microscopic examination of metals by all forms of illumination including vertical phase contrast and by visual, projection and protographic means.



Complete descriptive booklet on application

R & J BECK LTD · 69 MORTIMER STREET
LONDON W.1

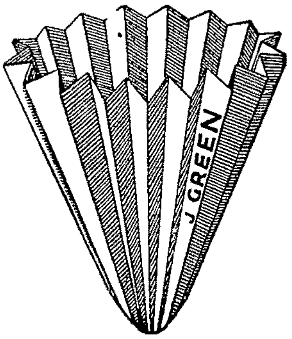
CIRCLES WITHIN CIRCLES

Concentric Circle Eyepiece Graticules have many specialised uses, particularly for engineers We have two similar patterns—progressing in diameter from 0 5 to 12 mm (Ref E 22), and from 1/64 in to 3/8 in (Ref E 23) in steps of 0 5 mm and 1/64 in respectively, each circle being numbered

As usual, the sharply defined image is protected by a cover glass, and graticules edged to 21 mm to fit the eyepiece of a standard microscope are normally available from stock

Complete list of Eyepiece and Stage Micrometers from

Graticules
LIMITED
57-60 HOLBORN VIADUCT, LONDON, E.C 1
Phone CENtral 2717/8 Grams Rheinberg, Cent, London



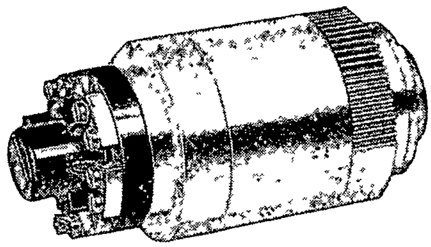
Green's Folded Filters

Always buy your Filter Papers ready folded, they are uniform and pure

Write for price list NG

J. BARCHAM GREEN LTD.
Maidstone • England

MUIRHEAD MAGSLIPS



for
REMOTE CONTROL
and
SERVO MECHANISMS

Write for Publication 7580

106

MUIRHEAD & CO. LIMITED
PRECISION ELECTRICAL INSTRUMENT MAKERS
BECKENHAM · KENT · ENGLAND

Printed in Great Britain by FISHER, KNIGHT & Co, LTD, The Gainsborough Press, St Albans, and published by MACMILLAN & Co, LIMITED, at St Martin's Street, London, W C 2, and ST MARTIN'S PRESS, INC, 103 Park Avenue, New York 17, N Y, U S.A —Saturday, February 12, 1955

NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye"—Wordsworth

INSTITUTE OF RADIO PHYSICS AND ELECTRONICS
LIBRARY
Date 29.3.55

Vol 175, No 4451 SATURDAY, FEBRUARY 19, 1955 Two Shillings

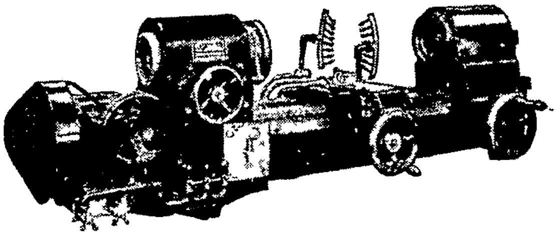
PHASE CONTRAST OUTFITS

- For excellent performance at modest cost
- Fit Baker or other microscopes made to accepted standards
- Available in powers × 10, × 40, × 100
- Outfits from £28 10s
- Complete instruments from £62 4s

C. Baker
OF HOLBORN LTD. EST. 1765

METRON WORKS, PURLEY WAY
CROYDON, SURREY (CROydon 6644)
London Showrooms· 244 High Holborn, W.C.1

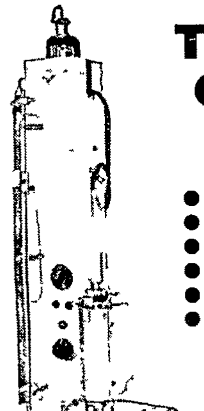
HEATHWAY GLASSWORKING LATHES
are known throughout the world



BENCH MOUNTING MODEL

★ *Other Models available* ★ *May we have your enquiries?*

HEATHWAY MACHINERY CO. LTD.
Uxbridge Road, Hillingdon, Middlesex
Telephone Uxbridge 6345



THE NEW B.T.L. VAN SLYKE GAS ANALYSIS APPARATUS

The Van Slyke Standard Manometric gas analysis apparatus has been completely redesigned to conform to modern practice and the following features are of particular interest

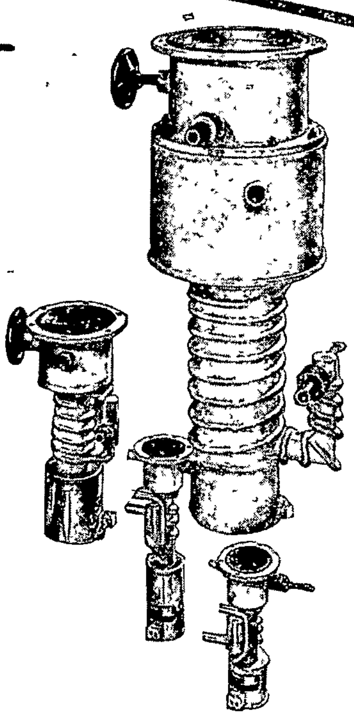
- Glass water jacket is illuminated to give a clear view of the shaking pipette
- Manometer fitted with illuminated meniscus-reader for accurate readings
- Easy adjustment of manometer and connecting tubes
- Totally enclosed motor and drive mechanism
- Rotary rheostat for control of shaking speed from a maximum of 200 per minute
- Timer and alarm buzzer can be fitted as an extra

Price £60 or with timer £70. Immediate Delivery. Full details will be sent on request

BAIRD & TATLOCK
(LONDON) LTD.
Scientific Instrument Makers
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

BTL
Member of
SCIEX

The WHEN? and WHY? of MERCURY VAPOUR PUMPS



These examples are but a few of the many specific applications of mercury vapour pumps which we manufacture to meet every research and industrial requirement—complete, if necessary, with valves, traps, backing pumps and lines and all accessories.

A new addition to our range is the MODEL 2M4, a very high backing pressure pump which can be isolated from the backing line for very long periods without loss of pumping speed.

ULTIMATE VACUUM: 10^{-6} mm.Hg.

When?	*Why?*
PUMPING AGAINST VERY HIGH BACKING PRESSURES	Achieves very high boiler pressures without fluid decomposition.
GAS "SAMPLING"	No decomposition products of the fluid to mingle with sample gas
MAKING RHODIUM MIRRORS BY VACUUM EVAPORATION	This metal is extremely sensitive to oil vapour which causes discolouring
EVACUATING SYSTEMS CONTAINING PHOTO-SENSITIVE OR SECONDARY-EMISSION SURFACES	The mercury pump combined with the liquid air trap keeps system entirely free from contaminants
EVACUATING MERCURY ARC, MERCURY VAPOUR LAMPS, ETC.	Mercury is already in system. No liquid air trap is necessary.
PUMPING CHEMICAL GASES AND VAPOURS	Many chemical gases will attack organic fluids.
PRODUCTION PUMPING OF MINIATURE RECEIVER VALVES	Ability to withstand rough usage on ultra-quick production cycles

W. EDWARDS & CO (LONDON) LTD

for better vacuum service

MANOR ROYAL · CRAWLEY SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

CASELLA LONDON

CASELLA

TEMPERATURE & HUMIDITY RECORDERS

for

• ACCURACY • RELIABILITY • ROBUSTNESS

The instrument illustrated is our recently improved model incorporating a bimetallic coil which gives a more rapid response to temperature changes and therefore more accurate recordings. It can be supplied with daily or weekly charts to a wide variety of ranges

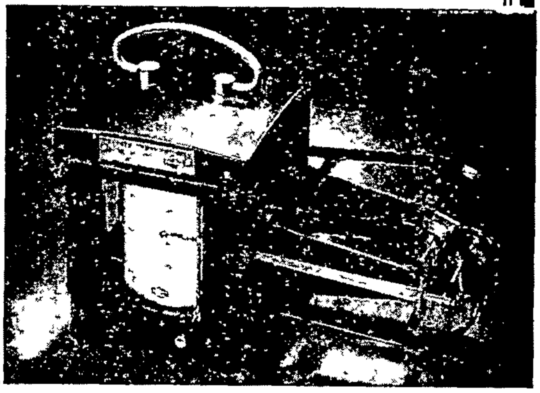
C. F. CASELLA & Co. Ltd.

REGENT HOUSE, FITZROY SQUARE
LONDON, W.1

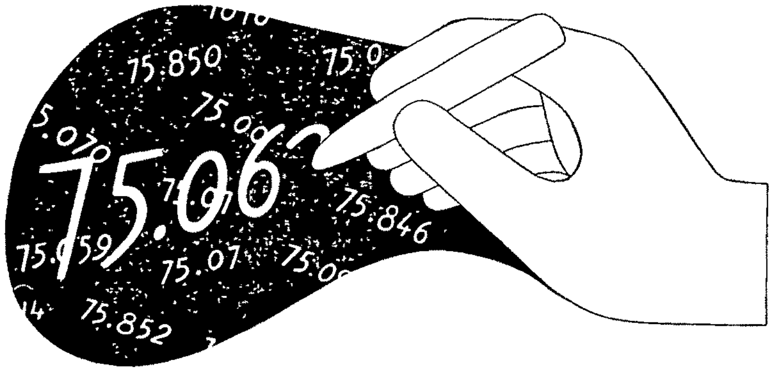
Telephone ★EUSton 3944

Member Scientific Instrument Manufacturers Association of Great Britain

The Thermograph



"The mean for these experiments gives 75 07 We therefore consider 75 as the true number indicated by these experiments for the atomic weight of carbon It is remarkable that this number was fixed upon theoretically by the English chemists and has now been confirmed by experiments"



... confirmed by the experts

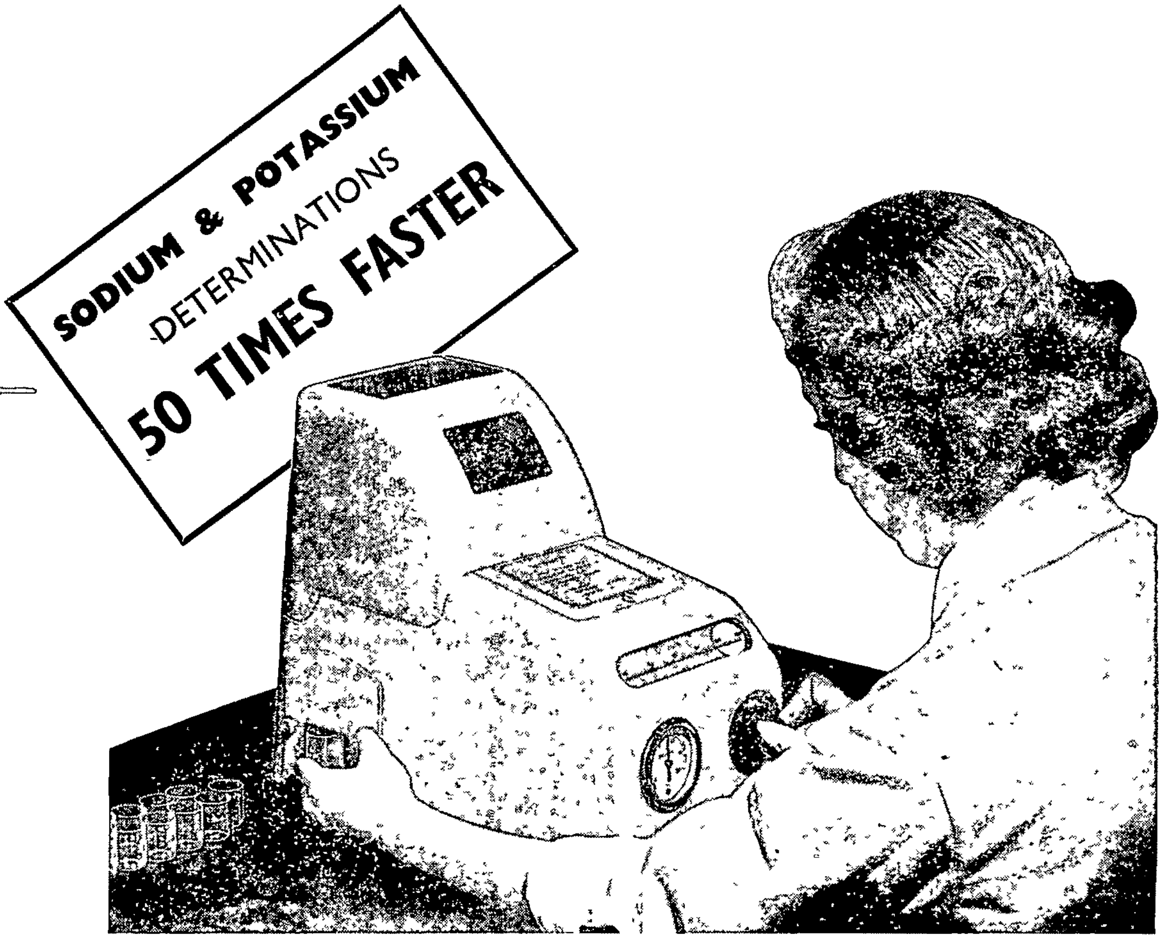
DR MARCHAND OF BERLIN made this statement in a letter recorded in the first volume of the Proceedings of the Chemical Society (1841), challenging the claim of Liebig and Redtenbacher to have established 75 854 as the correct atomic weight for carbon. In those days atomic weights were related to oxygen as 100, and it is notable that the 1951 atomic weight for carbon calculated on this basis is 75 063 compared with Marchand's figure of 75 07 derived from the combustion of diamond and graphite

Dr Marchand, whose methods were simple and direct, would have welcomed the convenience and accuracy of 'AnalaR' reagents It is even possible that they would have assisted the highly elaborate analytical work of Liebig and Redtenbacher to a more successful result

LABORATORY B•D•H CHEMICALS

THE BRITISH DRUG HOUSES LTD, B D H LABORATORY CHEMICALS GROUP, POOLE, DORSET

LC/P/8



With the

"EEL" FLAME PHOTOMETER

also invaluable for calcium and lithium determinations

Full details of this and other photoelectric instruments and photocells sent with pleasure

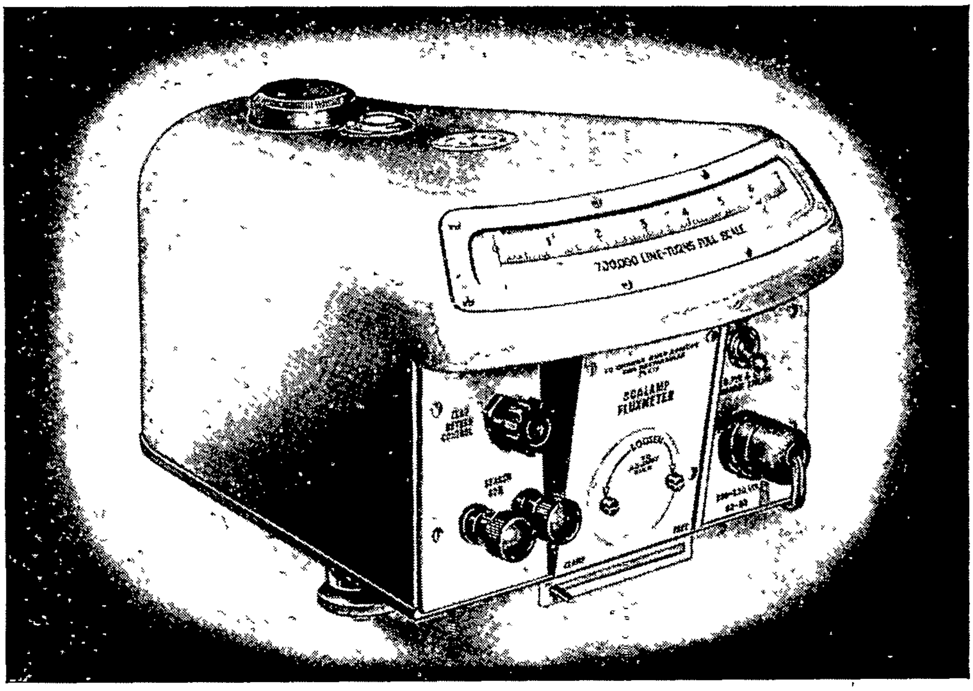
THE PRODUCTS OF

EVANS ELECTROSELENIUM LTD

SALES DIVISION 25 HARLOW ESSE

Representatives for sales and service

Manchester area —Messrs A. M Lock & Co, Ltd, Crompton Street, Chadderton, Oldham
North of England —Messrs Electricals, Ltd, 14 Claremont Place, Newcastle-upon-Tyne, 2
Scotland —Messrs. Atkins Robertson & Whiteford, Ltd, 92–100 Torrisdale Street, Glasgow S 2



SCALAMP FLUXMETER

Excellent design and the selection of the most suitable materials are combined to give this new FLUXMETER a truly outstanding performance. The drift rate with a search coil of 10 ohms or less is 0.1 per cent. A two speed "return-to-zero" control is fitted enabling measurements to be made with rapidity and ease. A spirit level and levelling feet facilitate setting-up and the automatic and manual coil clamps safeguard the suspension in transit. The illumination of the lamp bulb is effected either by an external 4-volt battery or by mains supply through the built-in transformer. Two search coils of mean diameter 1 cm and of area turns of 10 or 100 cm.^{2} are available.

Please write for our descriptive leaflet quoting Cat. No NT. 8834

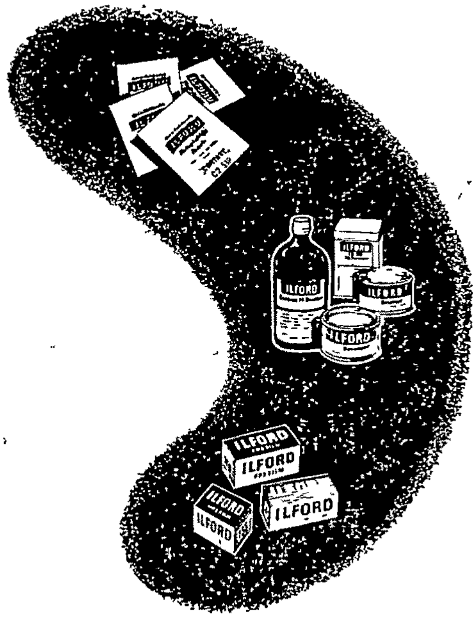
OUR NEW ILLUSTRATED CATALOGUE IS AVAILABLE ON REQUEST

SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO. LTD., GRANTA WORKS, CAMBRIDGE, ENGLAND
WG 55

In the interest of *accuracy*

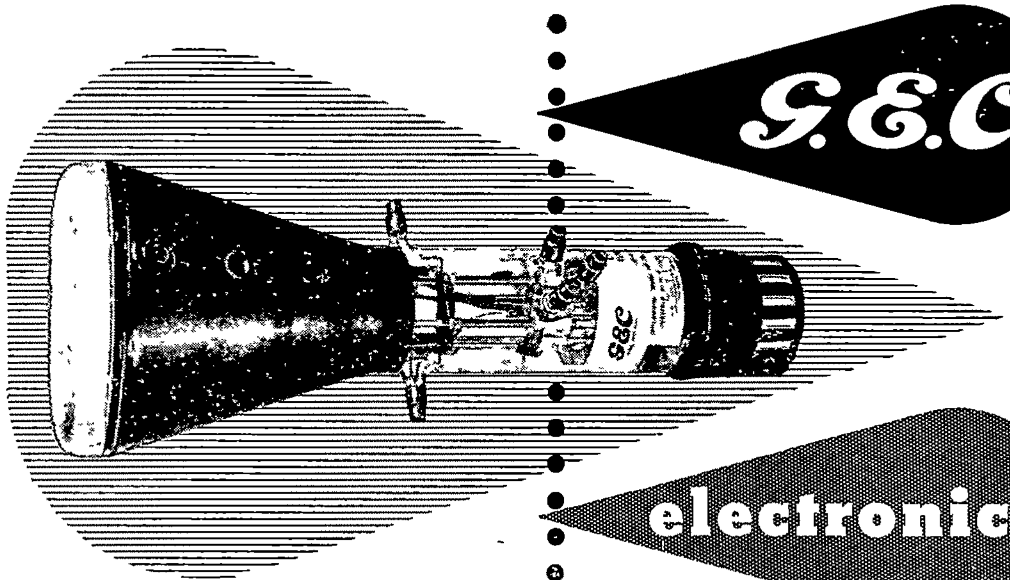
In the field of scientific photography, where performance must be capable of prediction and control within close limits, the consistently high quality of Ilford products has more than usual significance This accounts for the regular use of Ilford sensitised materials by scientific and industrial research organizations, both great and small, in every part of the world



ILFORD

PHOTOGRAPHIC MATERIALS
in the Service of Science

ILFORD LIMITED ILFORD LONDON



G.E.C.

electronics

Special purpose Cathode Ray Tubes
for Research and Industry

A range of cathode ray tubes is available for use in specialised applications such as the observation and recording of high speed transient phenomena, where the high capacitances and other limitations of the usual type of instrument tube would result in distortion or complete suppression of the trace

Typical applications of these special tubes include high voltage cable testing insulator overload and breakdown testing, cable fault finding by quasi-radar technique and the investigation of high voltage switching phenomena

They are also suitable for use in laboratory oscilloscopes

Brief details of some of the more popular types are given below The tubes are of the all-electrostatic type, with heater ratings of 4V, 1 0A (approx)

401 CAHA
408 CAHA
Rating
Va3 (max) 1 5kV
Vp d a 3 3 5kV
Sx (av) 0 090mm/V
Sy (av) 0 100mm/V
Screen 401 CAHA Green-visual
408 CAHA. Killed blue—photographic
Base B9G (pressed glass)

4cm dia high vacuum monitor tubes with one stage of post deflection acceleration For use in laboratory oscilloscopes, multi-channel strain-gauge recording equipment, etc.

908 BCC
Rating
Va3 (max) 10kV
Sx (av) 400/Va3 mm/V
Sy (av) 750/Va3 mm/V
Screen Killed blue—photographic
Base B12D

A 9cm dia flat screen high speed recording tube with a low capacitance deflecting system The connections to the plates and final anode are brought out through side-arms Writing speeds of the order of 30,000 km/sec are possible, and transients of the order of 10^{-9} sec may be recorded

908 CARA
Va3 4kV
Vp d a 8kV
Sx (av) 0 085 mm/V
Sy (av) 0 12 mm/V
Screen Killed blue—photographic
Base B12D

A 9 cm dia flat screen high speed recording tube with one stage of post deflection acceleration For use where the special features of the 908 BCC cannot be employed to full advantage The Y plate connections and final anode are brought out through side arms

1601 ABC
Va3 (max) 5kV
Sx 660/Va3 mm/V
Sy 1100/Va3 mm/V
Screen Green—visual
Base B12D

A 16cm dia flat screen high speed oscillograph tube The construction is of the low capacitance type with the deflector plates and final anode connections brought out through side arms

1608 BCCA
Va3 (max) 3 5kV
Vp d a 3 (max) 10kV
Sx (av) 0 15mm/V
Sy (av) 0 27mm/V
Screen Killed blue—photographic
Base B12D

A 16cm dia flat screen tube of similar low capacitance construction as the 908 BCC, but with three stages of post deflection acceleration This tube will achieve similar writing speeds and recording periods as the 908 BCC, and is recommended for use where the deflecting potentials available are limited

Alternative screens are available including long after-glow and white and blue aluminised types

Other types of special tubes are available including
Double gun tubes Storage tubes
Television monitor tubes
Conical deflection systems tubes for radial time bases Monoscopes, etc

Write to Osram Valve and Electronics Dept for full technical details

THE GENERAL ELECTRIC COMPANY LTD., MAGNET HOUSE, KINGSWAY, LONDON, W C 2

Tracer Compounds for Chemical & Biological Research

Some recent additions to our C.14 list:—

Margaric acid-1-C14
Glyceryl tri (stearate-1-C14) (Tristearin)
Glyceryl tri (palmitate-1-C14) (Tripalmitin)
Glyceryl tri (stearate-2-C14) (Tristearin)
Succinic acid-1-C14
Fumaric acid-1-C14
Maleic anhydride-1-C14
Phenyl (acetic acid-1-C14)
Cetyl alcohol-1-C14
Aniline hydrochloride (generally labelled)
D-Glucose-1-C14
D-Glucono-*delta*-lactone-1-C14
D-Mannose-1-C14
Carbon (elementary)
Sodium *iso*-caproate-1-C14
DL-Leucine-1-C14
Sodium pyruvate-2-C14
Sodium pyruvate-3-C14

•

We can now supply more than one hundred compounds of carbon-14.

•

For further information write to.

THE RADIOCHEMICAL CENTRE, AMERSHAM, BUCKINGHAMSHIRE,
ENGLAND

These products are distributed in U.S.A. by the Nuclear Instrument and Chemical Corporation of Chicago

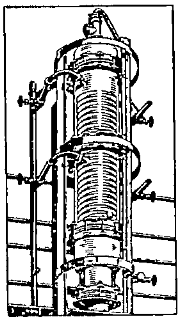
TAS/RC.8.

A skilful group
of practical *and*
technical experts

QUICKFIT
Visible Flow

Q.V.F. Ltd builds
INDUSTRIAL PLANT IN GLASS

is ready to serve
you on any question of
the adaptation of
Industrial Plant in Glass
and Visible Flow Pipeline
to your manufacture.
Constructive planning
or advice are yours to
command as well
as the largest
manufacturing facilities
in the country.
May we hear from you?



Telephone STONE 511.

Q.V.F. LIMITED
Mill Street, Stone, Staffs.

Ediswan now have available a new stabilised power supply unit which has been specially designed to feed Photo-Multipliers It is particularly suitable as a supply unit for Ediswan Mazda Photo-Multipliers type 27 M1, 27 M2 and 27 M3

BRIEF SPECIFICATION — Type R 1184

INPUT	OUTPUT	STABILITY	OUTPUT RESISTANCE	RIPPLE
200–250 v, 40–100 c p s	High stability low ripple D C supply variable between 300 and 1,100 volts Max current 2 mA Pos or neg may be earthed	A 10% change in mains input voltage results in a change of less than 0 1% between 1,100 volts and 600 volts output	Approximately 1,500 ohms	Less than 0 01% R M S

MOUNTING The Unit is suitable for standard rack mounting or for bench use Bench Stands are available

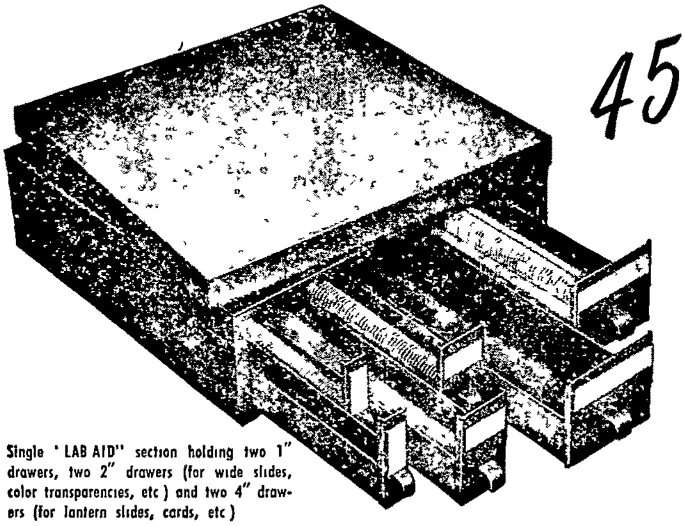
PRICE — £48

Further information is available on request

EDISWAN

RADIO DIVISION · THE EDISON SWAN ELECTRIC COMPANY LIMITED
155 Charing Cross Road, London, W C 2 *Telephone* Gerrard 8660 *Telegrams* Ediswan, Westcent, London
Member of the A E I Group of Companies

SP



45% greater capacity

cuts filing costs . . .

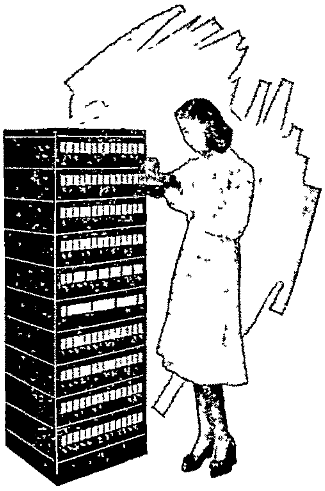
saves floor space

Single "LAB AID" section holding two 1" drawers, two 2" drawers (for wide slides, color transparencies, etc) and two 4" drawers (for lantern slides, cards, etc)

How can a Technicon "LAB-AID" filing cabinet measuring only 19" square by 5" high hold up to 6500 (average) one-inch microslides? The single section illustrated here with its drawers extended will show you why . . it's because there are no thick bulkheads between drawers — no space-consuming buttresses, no bulky tracking guides Yet, close-set as they are, every drawer slides straight and true . . easily, smoothly, without binding.

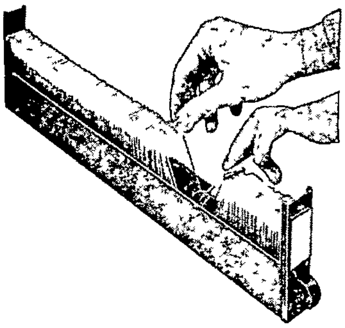
Drawers are freely interchangeable, too, thanks to the unique "LAB-AID" unit-gauge track system, so that you can intermix 1" drawers with 2" drawers (even 4" drawers, if you like) according to your needs

Staunch, fireproof "LAB-AID" units are strongly built of heavy gauge steel for a lifetime of satisfactory use Beautifully finished in olive green enamel, with combination drawer-pulls and label holders Separate bases and finishing cap panels make complete units of any number of sections your filing needs require, expandable at will at any future time.



A stack of ten sections, complete with base and cap panel Interlocking design lets you pile sections right up to the ceiling Staunch "LAB AID" construction easily bears the heavy weight of solidly packed slides

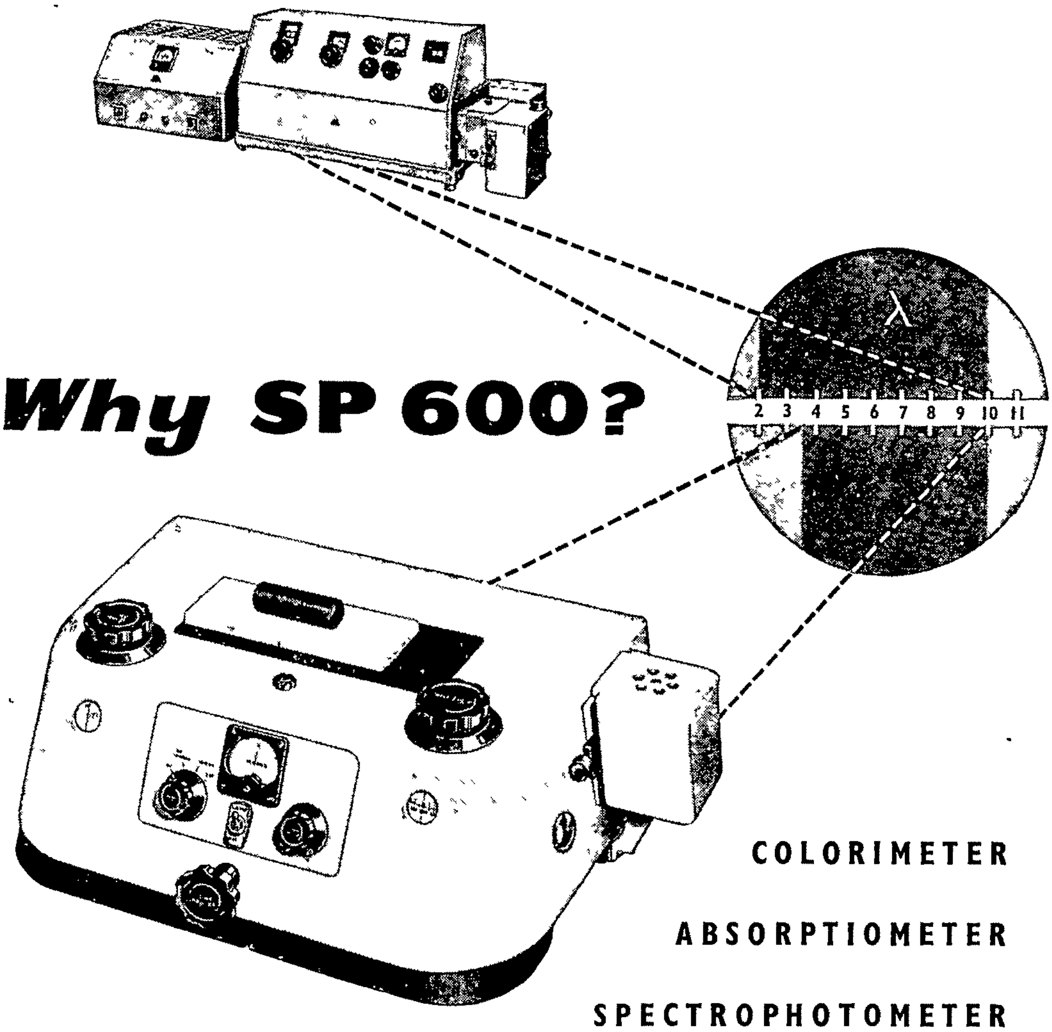
For filing current slides, the removable spring separator lets you riffle through them as easily as you flip the pages of a book . . easy to file, easy to find Slip it in when you need it, take it out when you use the drawer for storage filing



TECHNICON Lab-aid laboratory filing cabinets

Technicon "LAB-AID" filing cabinets have long been standard filing equipment in laboratories throughout the world Now made in France, they can be easily imported into the United Kingdom

COMPAGNIE TECHNICON
Postal Address only in U.K.:
7 Lytton Gardens, Wallington, Surrey



Why SP 600?

COLORIMETER

ABSORPTIOMETER

SPECTROPHOTOMETER

In every way the SP 600 Spectrophotometer makes an ideal complement to the familiar SP 500 There are analytical problems (in the field of metallurgy, for example) which demand an instrument capable of precise absorption measurement at carefully selected wavelengths, but for which ultraviolet equipment is not necessary

The SP.600 is designed to provide exactly these facilities

The dispersion of the glass prism and the high quality optical system give a resolution unobtainable with filters and the electronic detector-amplifier makes the instrument exceptionally sensitive. It is robust, easily operated and moderately priced

Arrangements can be made for a comprehensive test in your own laboratory, without obligation Please write for details.

UNICAM

SPECTROPHOTOMETERS

UNICAM INSTRUMENTS LTD · ARBURY WORKS · CAMBRIDGE

U144B

NATURE

No 4451 SATURDAY, FEBRUARY 19, 1955 Vol. 175

CONTENTS

Page

Potential Scientists and Technicians in the Schools 313

Henry Edward Armstrong By G Fowles 316
The Interaction of Science and Society By Prof E J Dijksterhuis 316
Higher Transcendental Functions By Prof Thomas M MacRobert 317
The 'Chemistry' of Atomic Nuclei By Prof H W B Skinner, F R S 317
Shrunken Heads By Dr E Ashworth Underwood 318
Biochemistry of Cancer By Prof E Boyland 318

Thermonuclear Explosions and the Weather By Sir Graham Sutton, C B E , F R S 319
Origin and Age of Meteorites By Prof Harold C Urey, For Mem R S 321
Higher Technological Studies in Northern Ireland By Dr Eric Ashby 323
Carl Friedrich Gauss as a Physicist By Dr N Davy . 325

Obituaries ·

Prof. G V Anrep, F R S By Sir Charles Lovatt Evans, F R S 326
Mr A S Ramsey By Dr D. W Babbage 327
Mr Edwin Grey By H V Garner . . 327

News and Views 328

Early School Leaving. By T H Hawkins 331
Centenary of Aluminium . . 332
The Vicuna 332
A New Identification of the Flame Spectra of the Alkaline-Earth Metals. By Dr C G. James and Dr T. M. Sugden . 333
Electrified Droplets from the Bursting of Bubbles at an Air–Sea Water Interface By Duncan C Blanchard . . 334
Occurrence of a New Base in the Deoxyribonucleic Acid of a Strain of *Bacterium coli* By D. B. Dunn and Dr J D Smith 336

Letters to the Editors

The Endocrine Chain in an Insect —Prof V B. Wigglesworth, C B E , F R S 338
A Critical Response to Changing Length of Day in an Insect —Philip S Corbet 338
A Model of Cortical Activity —J Sutin and Dr. B Campbell 339
Sialic Acids —G Blix, E Lindberg, L Odin and I Werner 340
Biological Decomposition of Aromatic Nitro-compounds —H. L Jensen and K Gundersen 341
Meaning of 'Turnover' in Biochemistry —Prof Max Kleiber 342
Feulgen-negative Nuclear Division in *Habrobracon* Eggs after Lethal Exposure to X-Rays or Nitrogen Mustard —Dr R C von Borstel 342
Chromosomes and Nucleoli in *Pisum sativum*.—J W Morrison and Shu-Chang Lin 343
Use of the Mouse for Detection of Small Numbers of Tubercle Bacilli —Prof John Francis . 344
Larvæ of *Sphaerophoria* as Predators on Thrips in South Africa.—Dr E McC Callan 345
Alkaline-Earth Borohydrides and their Applications in Organic Syntheses —J. Kollonitsch, O. Fuchs and V Gábor 346
Inhibition of the First Limit of the Hydrogen–Oxygen Reaction by Ethane —R R Baldwin and R. F. Simmons 346
Photosensitivity of Iron Chelates.—D G Hill-Cottingham 347
Deposit of Spheroidal Graphite —B Vasiliou, E W Roberts and Dr G R Rigby 348
Geological Ages of Witwatersrand Uraninites —J D Louw 349
Proposal for a New Æther Drift Experiment —D D Crombie . . . 350
Use of Soluble Filter Gauzes —M A Naughton and J M Swinstead 351
Method for Recovery of Metallic Grids for Electron Microscopy —Persio de Souza Santos . . 351
Use of Methyl Cellulose Gel as a Substitute for Agar in Tissue-Culture Overlays —Dr. J E Hotchin . . 352
Preservation of Dogfish —Dr H F Steedman . . . . - . 352

A service well worth remembering . . .

The Kodak service to scientists and technicians includes the provision of photographic plates made to special formulae.

This range of 'Kodak' Scientific Plates includes 84 selected combinations of 16 colour-sensitizing classes and 8 emulsion types differing in speed and contrast They are not normally stocked, but are supplied to special order—a service well worth remembering when no commercial plate seems to fit your requirements

Other 'Kodak' Scientific Plates cover specific laboratory requirements

'Kodak' Uniform-Gamma Plate

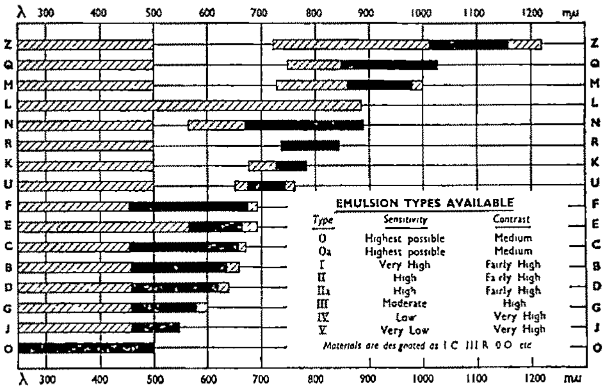
Used in ultra-violet spectrography to obtain a much more uniform contrast over the spectral range 250-400$m\mu$ Available to special order

'Kodak' M R. Maximum Resolution Plate

Has an almost grainless emulsion and a very thin emulsion layer Specifically produced for very high resolution photography, for graticule production, and for X-ray micrography Stocked in ¼-plate and ½-plate sizes

'Kodak' Autoradiographic Plate

Used for tracing small amounts of radioactive substances, and to study 'tagged' atoms within the macrostructure of animal or plant tissues Stocked in ½-plate size



EMULSION TYPES AVAILABLE

Type	Sensitivity	Contrast
O	Highest possible	Medium
Oa	Highest possible	Medium
I	Very High	Fairly High
II	High	Fairly High
IIa	High	Fairly High
III	Moderate	High
IV	Low	Very High
V	Very Low	Very High

Materials are designated as I C III R O O etc

The chart shows the wavelength to which each of the 16 *colour-sensitizing classes of 'Kodak' Scientific Plates is sensitive, and the region of special sensitivity*

Kodak

PHOTOGRAPHIC PLATES

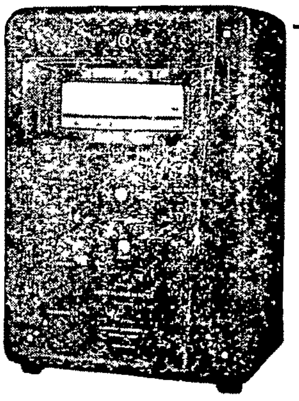
for scientific and industrial use

Kodak Limited (Industrial Sales Division), Kodak House, Kingsway, London, W C 2. *'Kodak' is a registered trade-mark*

Instruments for Research and industry

Direct Reading pH Meter

A robust and exceptionally stable mains-driven instrument which is being widely used by leading firms, both at home and abroad. The 6-inch mirror scale meter may be read to 0.05 pH, and the normal zero stability of the instrument is ± 0.02 pH. There are two pH scales: one reading 0–14 pH and the other giving a coverage of 7 pH over any part of the scale. A millivolt scale is also included and automatic temperature compensation is provided from 0° to 60° C.
A complete range of laboratory and industrial electrode systems is available for use with this instrument.



MODEL 23

ELECTRONIC INSTRUMENTS LIMITED

RICHMOND : SURREY : ENGLAND

POTENTIAL SCIENTISTS AND TECHNICIANS IN THE SCHOOLS

IN its fifth annual report nearly three years ago the Advisory Council on Scientific Policy noted that prejudice against an industrial career and lack of knowledge of its opportunities on the part of both parents and teachers were responsible for robbing the nation of potential talent in science and technology. A recent investigation made by the Physics Department of the University of Bristol, and reported by Prof N. F Mott and N. Thompson in the *Universities Quarterly*, on those candidates for admission to the honours school of physics there who are not accepted, suggests that, of the boys with ability but no inclination to study science to be found in the arts sixth forms, some at least might have chosen to study science if they, their parents and their headmasters had been fully aware of the need of the community for well-educated scientists and the opportunities open to such men. The seriousness of such ignorance has, however, usually been emphasized more particularly in respect of the shortage of scientists than in regard to scientific and technical man-power generally. The Parliamentary and Scientific Committee, it is true, in its memorandum on Higher Technological Education issued last July, commented on the importance of creating a bigger demand from the school population of Britain for education in science and technology, and in opening a debate on this memorandum in the House of Lords on December 7, Lord Glyn affirmed that many promising pupils in the secondary schools are discouraged from technological studies Lord Salisbury stated in that debate that about two-thirds of the boys in the sixth forms of grammar schools as a whole are taking science as their main subject of study, and that, of the eight thousand State scholars n the country, some five thousand are studying science, but he agreed that all possible steps should be taken to attract a good proportion of the ablest boys and girls to a scientific career

Nevertheless, a committee on the Shortage of Science Teachers, set up by resolution of a conference convened by the Federation of British Industries n January 1954, reported that probably the most mportant untapped source of potential science graduates is to be found among the able pupils who eave the grammar schools at sixteen. That committee expressed the hope that the schools, with the ull support of the local education authorities, would ucceed in convincing these boys and girls and their parents of the value of the sixth-form course and hus prevent this waste of ability. Since then, a eport published by the universities committee of the Association of Scientific Workers, based on a questionnaire sent to 303 secondary grammar schools, direct-grant schools, and independent schools, has suggested hat an increase of at least twenty per cent, and even up to fifty per cent, in the number of suitable science students at the universities is possible if all suitable grammar school boys and girls could be persuaded to complete a sixth-form course At present, twenty-one per cent of those who left local education authority schools and fifteen per cent of those who left independent and direct-grant schools would, in the opinion of their teachers, have benefited from the sixth-form course, while thirty-two per cent of those in science sixth forms in local education authority schools and twenty-three per cent in direct-grant and independent schools left to take up jobs when, in the opinion of their teachers, they should have proceeded to universities.

This estimate has now been endorsed by the broader and more systematic study of premature school-leaving in England undertaken for the Minister of Education towards the end of 1952 by the Central Advisory Council for Education (England) (see also p. 331) The inquiry was to consider what factors influenced the age at which boys and girls leave secondary schools which provide courses beyond the minimum school-leaving age in Britain (at present fifteen), the extent to which it is desirable to increase the proportion of those who remain at school, particularly the proportion of those who remain at school to the age of about eighteen, and the steps to be taken to secure such an increase. Broadly speaking, the report of this inquiry[*], which is based on a ten per cent sample of maintained and direct-grant grammar schools in England, fully establishes that while the practice of early leaving is declining, there is still an important leakage of potential scientists Of the grammar school intake of 1946, in addition to about 10,000 boys and 7,000 girls who took advanced sixth-form courses, there were in addition about 5,000 boys and 5,000 girls with the capacity to do so if they had stayed longer at school, and of those some 2,900 boys and 1,300 girls would have been suited for courses in mathematics and science. If all these boys and girls had completed advanced courses, the number of boys taking sixth-form courses would have been increased by about half, and the number of girls by about two-thirds

Nevertheless, the value of the report lies not so much in its demonstration of a loss of at least 4,000 potential scientists or technologists—including science teachers—as in its clear presentation of the factors that require consideration in determining either immediate action or long-term policy. The Council's estimate that less than half the present intake into grammar schools could profitably take sixth-form courses is a reminder of the need both for action to prevent waste of public expenditure and for caution in deciding on the measures by which the leakage of talent is to be checked.

---

[*] Ministry of Education Early Leaving a Report of the Central Advisory Council for Education (England) Pp. vii+99 (London: H M Stationery Office, 1954) 3s 6d net

The Council's attitude to the extension of the school life beyond sixteen is thoroughly realistic It rejects as inadequate by itself both the approach which asks whether continued education will assist a child to develop more fully as an individual, and also that based on whether it will fit him or her for the work he or she may be called upon to do later in life "A child," it says, "must grow up into the community and adjust himself to its economic demands and moral obligations , and it is wrong to create the illusion in the child's mind that he has the right to demand from it the kind of life that pleases him or will give him the greatest scope for self-expression regardless of the needs of others " That was worth saying to-day. But the report continues "a citizen's economic role is not his whole life . . . no economic system will ever be so organized that everyone will use his whole talents in his employment . . . education must not confine itself to cultivating those abilities which may be economically useful but should be given in good measure to develop the whole man".

The Council, accordingly, suggests that academic ability should be the first determining factor. If the interest of a pupil flags as the work of the school in the upper forms calls for increased power of abstract thought beyond his or her capacity, the school should not try to persuade the pupil to stay. Nor should it seek to retain those in whom school life produces a real and continuous sense of frustration.

The Council thus recognizes that there are some boys and girls who, because of their intellectual or emotional characteristics, should leave school before they are eighteen these may well be the school leavers which industry, as the Federation of British Industries has recently pointed out, should be seeking more actively to recruit While satisfied that there is enough academic ability to justify an increase in the number of boys and girls following advanced courses by about a half and two-thirds, respectively, the Council is dubious as to the wisdom of enforcing generally a leaving-age of sixteen or even a statutory differential leaving-age for grammar schools. The significant reduction in early leaving manifest in recent years does indeed suggest that ultimately, as the educational changes of recent years have their full effect in the homes, some of the factors which at present encourage early leaving will lose force. Nevertheless, the Council is not content to rely on such long-term tendencies, and if only as a contribution towards meeting the present national need for scientists and technologists, its proposals, though somewhat tentative, should receive vigorous support.

Those proposals are already being considered by Sir David Eccles, as he indicates in his foreword, and the reservations he obviously has are rather on the financial side. Sir David takes the reasonable view that the main purpose of any increased maintenance allowances, such as the report recommends, should be to help the right pupils to stay at school—to give help where there is both need and merit. Whether an all-round increase in the proportion of grammar school places is desirable is less certain, and the Council makes some comments on the importance of developing courses both in modern schools and in technical colleges and other institutions as alternatives to sixth-form work , the implications of these proposals require fuller examination than they are given in this report

The report is, as so often happens, stronger in diagnosis than in the prescription of remedies for what is wrong It suggests, for example, that more opportunities for transfer from modern schools to grammar schools are required, but without examining in any detail the difficulties involved, or discussing the reverse process It has little to say about the ways in which the parental attitudes could be changed, although unfavourable home influence is a decisive factor here, as it is also the main cause of the waste of talent through early leaving.

On that point the report provides clear evidence, though the reasons why the middle classes make the best use of educational opportunity are by no means equally clear , the report itself suggests that more precise study of home backgrounds in relation to education is much needed, particularly of the effect of the home background of the semi-skilled and unskilled worker upon a child's education at a grammar school. Children from professional and managerial families account for 15 per cent of the school population, but for 25 per cent of that of the grammar schools and for 43 7 per cent of the sixth forms. Not only is the performance of such children in the selection tests at eleven better, but also they stay at school longer and they do better at the grammar schools. "From the children of parents in professional or managerial occupations at one extreme to the children of unskilled workers at the other, there is a steady and marked decline in performance at the grammar school, in the length of school life, and in academic performance at the time of leaving. This is not a mere development of the better performance at the age of eleven of children in certain groups , it reflects a widespread changing of places in academic order between eleven and sixteen or eighteen."

As a corollary it follows that the risk of waste of public money in fees and maintenance allowances increases as performance declines in this way. This is no argument for reserving a proportion of grammar school places for those whose parents are willing to pay fees—a suggestion firmly rejected by the Council —though it suggests that it is wise to take account of the fact that there are some boys and girls whose outlook and lives are dominated by the traditions of their family, and by friends favouring early earning and independence and opposed to a long school life The Council wisely observes that care should be taken not to handicap further the children of unskilled workers who are most subject to such influences This influence and outlook are bound to be affected by changes in the education which the parents themselves have received. "The effect on the grammar schools of the changes introduced in 1944 will not be properly seen until the boys and girls affected by them in their school days themselves have children of secondary school age "

Apart from this, the report also makes clear that shortage of money is in itself a less common reason for leaving than some others Financial considerations, however, affect the decision to leave for an appreciable number of children, especially among those of semi-skilled and unskilled workers, and for this reason the Council concludes that the existing schemes of aid are not fulfilling their function and that there is a clear case for improvement, either by increasing the rates of grant or extending the parents' ncome-range, or both. The Council did not examine the financial implications of its proposal, nor has it fully explored the social or political implications, though the complexity of the problem is clearly ndicated

Perhaps understandably enough, the Council was reluctant to grapple with the implications of this forthright demonstration that, in education and in ife, heredity and environment do, after all, matter a great deal It was not expected of the Council that t should express an opinion as to whether it is more n the public interest to remove all handicaps to the development of every outstanding intellect or to make sure that every mediocre intellect has a chance It has at least suggested some practical steps for making the dilemma less acute, but none the less, n doing so, it might have been expected to face more fully the minor dilemma which arises when it considers the immediate action required to stop the eakage of potential scientists

There can be no doubt that it would be worth aking all possible steps to obtain even half the additional scientists which the report suggests are being lost each year. The report gives no indication as to how this should be done, though it would seem hat the most obvious measures are those already uggested by the Advisory Council on Scientific Policy, and which for a different purpose the Federaion of British Industries has already begun to apply —publicity and persuasion Even here the implications seem to merit a little closer examination The report points out that if we succeed in inducing more boys and girls to stay on in the sixth forms, whether the science sixth or not, they will, *ipso facto*, be diverted from other careers, and such vidence as this inquiry has yielded suggests that most of them will be diverted from some sort f clerical career, apprenticeship or laboratory work.

For the first two groups the maximum numbers would be no more than about one-seventh or oneighth, even if all the qualified boys and girls were diverted to more advanced forms of training, and he Council admits that it is desirable that some such boys and girls, if not the most intelligent, should ollow these types of career There are other bodies, uch as trade unions, besides industrial firms, which hould welcome this source of recruitment of potential eadership The loss among laboratory technicians is more serious, not simply because quantitatively it may amount to some thirty-six per cent, but also because of its bearing on the efficient use of existing scientists and technologists This aspect is dismissed too cavalierly by the Council. It may be wasteful to employ as technicians boys and girls capable of qualifying as first-class scientists and technologists, but it is equally wasteful to employ a trained scientist or technologist on duties which could be carried out equally well, and perhaps better, by a less highly trained technician The Council, in fact, scarcely seems to appreciate the extent to which the work of the laboratory technician demands skill and intelligence, or the imperative need at the present time of making the utmost use of the services of technicians to relieve the existing shortage of scientists and technologists

That has been repeatedly emphasized in recent discussions on the shortage of science teachers in particular, for example, by Dr Eric James at the conference of the Universities of Great Britain and Northern Ireland last December, when he asked whether industry is using its scientists efficiently, and it has always been recognized in discussions on the expansion of higher technological education that many more technicians than technologists and scientists will always be required More harm than good may well be done if attempts to persuade boys to stay on in the science sixth to take up a career as scientist or technologist, following a course at a university or a college of technology, convey the impression that that of technician is of low esteem or in any way less important It is at least for consideration that for some boys and girls a period in the science sixth may be the most appropriate prelude to a career as a laboratory technician, and the Council suggests generally that professional bodies and employers could alter their conditions of entry to encourage staying at school until eighteen

Any approach to parents or to teachers suggesting a national need for a particular kind of talent is open to the implication that other careers, though less exacting intellectually, are inferior in either importance or esteem Such an approach may well be the most promising immediate step, but it should be supported by those auxiliary means of helping the child handicapped by home conditions, such as providing opportunities for evening study in the public libraries or schools, which the Council suggests In such matters the Minister of Education's influence could be decisive, and it is to be hoped that controversy over the more dubious financial proposals will not distract attention from such immediate ameliorative measures Ultimately, as the report makes plain, the solution lies with public opinion, within and without the home, and one step which scientists and technologists themselves could take is to press for some reasonable and authoritative estimate of the nation's requirements for technicians in relation to the need for scientists and technologists Such an estimate, based on a realistic conception of the efficient use of trained man-power, is an essential basis for any publicity on a national scale, or approach either to parents or teachers, in terms of the national need for such talents

HENRY EDWARD ARMSTRONG

Henry Edward Armstrong

Educational Work By Charles E Browne. Pp xiii+26+4 plates (London Christ's Hospital, 26 Great Tower Street, E C 3, 1954) 6*s*.

THE title of this book is too comprehensive for the restricted scope of its contents A volume so slender can tell us little about its subject and less about his extensive educational work 'H. E A.', a man of remarkable personality, great vitality and vigour of mind, a prophet and a visionary, besides being a deep and versatile scholar of critical outlook and independence of thought, was a prolific writer and forceful speaker and had a rare gift of expression Conscious of a mission and burning with the fiery zeal of reform, he marshalled his great gifts and directed his efforts towards improving science teaching in the schools of Britain, and arousing and educating the public to a realization of the ever-increasing influence of science in human affairs

A fearless advocate of the causes he had at heart, he was an indefatigable educator and reformer. His weapon was the strength of his arguments, clearly and persistently put forward, his weakness, his use of biting wit and bitter comment. For he made little use of patient persuasion and delighted in stinging his audience. He admitted the unpleasantness of his methods, necessary, he maintained, to arouse people out of their apathy and indifference and make them think. Supineness and complacency, whether in a community or a person in authority, roused his wrath He was the stormy petrel of every committee on which he sat, the terror of editors of scientific journals, and the critic of everyone straying from the path of the scientific method

By his articles and letters to the Press, Armstrong attempted to educate the public on scientific matters He exhorted farmers to study the cultivation of sweet grass and repeatedly pointed out the health value of pure milk and wholesome bread. Ahead of his time, he urged that the scientific method should be applied to the exploitation of the Coal Measures of Britain. Again, he brought forward strong arguments for making a survey of the world's resources His edifying addresses to professional chemists—critical, hortatory and inspiring—are as pertinent to-day as when they were written Many pupils who owed their chemical education to him later became distinguished university professors. The booklet under review has of necessity little mention, not to speak of expansion, of the above educational activities

From the storm and turmoil of heated controversy, Armstrong seems to have found a psychological rest in his service to Christ's Hospital He was a governor of this old and richly endowed London school for more than forty years, and was influential in getting it removed to Horsham in Sussex There, amid ideal surroundings, with spacious well-equipped laboratories, very small classes and a specially selected staff, all due to his initiative and drive, he was able to get science taught in a way dear to his heart The boys were trained in the art and method of discovery, and learned only what could be argued from experiments carried out by themselves, a method of teaching later called 'heurism'. Most of the text and all the illustrations of the booklet are concerned with this phase of Armstrong's educational work. Sir William Hamilton Fyfe, headmaster in Armstrong's day, contributes the charming an laudatory prologue, in the epilogue, Dr G. va Praagh, the present senior science master, in summin up the "Heuristic Method To-day", has nothing t add to what is already known The author, the chie member of the science team collected by Armstrong pays a pious tribute to his old master, and is warml appreciative of the work he did for Christ's Hospita The book should delight the 'Old Blues' who cam under the influence of 'H E. A', and should help t keep fresh the memory of one who did his utmost t urge scientists to make ceaseless effort.

G. FOWLES

THE INTERACTION OF SCIENCE AND SOCIETY

Science in History

By Prof J D Bernal Pp. xxiv+967 (London C A Watts and Co, Ltd, 1954) 42*s*. net.

NEITHER of the two terms occurring in the titl of this volume must be taken in the strict sens tradition attributes to them, in which science mean natural science only and history is exclusively relate to the irrevocable past. Science here covers soci sciences as well, and the history that is told extend to the date of publication of the book

One need not read far to become aware of th motives prompting the author to take this broad an comprehensive view of his subject It was not hi intention to deal with history for history's sake, bu as a means of understanding the interaction of scienc and society, the importance of which is so con spicuous in these days and will surely become sti clearer in the future Accordingly, the historica approach plays the part of an introduction, and th author's aims would have been wholly thwarted i he had stopped short at the end of the nineteenth century, where as a rule works on the history o science have their time limit

There is another thing which is clear to the reade from the very beginning of the book, namely, tha the author considers the vicissitudes of science i the past and present from a deliberately Marxis point of view. He is convinced that not only th means used by scientists in their researches but als the guiding ideas of their theoretical approach ar conditioned by the events and pressures of society that scientific problems are set in the first place b actual economic necessity, and only in the secon place do they arise out of earlier scientific ideas, tha a new economic system inevitably involves a differen experimental science, that history has to be interpreted in terms of economics only and that consequently science in each period of its developmen has to be treated as a social and economic phenomenon

In my opinion, this way of looking at the histor of science means that an undoubtedly importan aspect of development, namely, the indisputabl relations between science and society, is unnecessarily made absolute, and raised to a status o uniqueness, with the neglect of numerous othe equally important influences Nevertheless, I mus acknowledge the excellent manner in which th author acquits himself of the task he undertook His mastery of the most diverse subjects in th history of science and in its present phase deserve the highest admiration. The way in which h expounds his views is perfectly clear As he avow his political ideas without any reserve, he is likely to hurt many a reader's feelings. This, however, should not be a reason for leaving the book unread. As the views developed are highly important and influential in these days, one will only harm oneself by not seizing the opportunity of seeing them defended in so masterly a fashion. As to the hurt, it will have to be taken into the bargain.

It would, of course, be quite out of place to direct the attention to some minor historical errors occurring in the work, the more so as they do not invalidate the theses sustained. E J DIJKSTERHUIS

HIGHER TRANSCENDENTAL FUNCTIONS

Higher Transcendental Functions

Based, in part, on notes left by the late Prof Harry Bateman, and compiled by the Staff of the Bateman Project. Vol 1. Pp. xxvi+302. 52s. Vol. 2. Pp. xvii+396. 60s. (London: McGraw-Hill Publishing Company, Ltd., 1953.)

THE rapid growth of mathematical knowledge and the multiplication of mathematical journals throughout the world make it increasingly difficult for the mathematician to keep abreast of his subject. For this reason the great project, first proposed by the late Prof. Harry Bateman, and so ably being carried out by Prof. A. Erdélyi and his colleagues, will earn the gratitude of great numbers of mathematicians, pure and applied. These two volumes, apparently to be followed by others, cover an extremely wide range. They contain thousands of formulæ, usually with some indication of origin, and frequently with suggestions as to methods of proof. At the end of each chapter is to be found a most useful list of relevant papers and books.

The first chapter deals with the gamma and beta functions, the second with the hypergeometric function. This is naturally followed by a chapter on the Legendre functions. It seems a pity that the authors did not take the opportunity, in this chapter and elsewhere, of giving a lead out of the morass of notations, so confusing to the student. For example, it is unfortunate that the notations $P_\nu^\mu(z)$, where $|z| > 1$, and $P_\nu^\mu(x)$, where $-1 < x < 1$, should refer to two different functions. After all, z can be replaced by $x(> 1)$ in the first function, and there is no reason why the argument of the second function should always be real. It is a simple matter to denote the second function by $T_\nu^\mu(z)$, as mentioned on page 179, and so avoid all ambiguity. It is high time also that Hobson's unfortunate notation for $Q_\nu^\mu(z)$, involving a factor $\exp i\mu\pi$, should be discarded. This factor was introduced to make the definition consistent with the definition when μ is a positive integer, namely,

$$Q_\nu^\mu(z) = (z^2 - 1)^{\frac{1}{2}\mu} \frac{d^\mu}{dz^\mu} Q_\nu(z).$$

In order to avoid the complex factor, Barnes replaced it by the factor $\sin(\mu + \nu)\pi/\sin(\nu\pi)$, thus ensuring that the function should be real for z real and greater than unity, but unfortunately making it vanish identically or become non-existent for certain values of μ and ν. The simplest thing to do is to insert a factor $(-1)^\mu$ on the right of the equation above, and then these troublesome factors are not required.

Again, it seems scarcely necessary nowadays to stress the Gegenbauer polynomials, as these can be expressed in terms of associated Legendre functions.

The fourth chapter deals with various types of generalized hypergeometric functions, and the fifth with E-functions, Meijer's G-functions and generalized hypergeometric functions of two variables. The E-functions have proved a powerful instrument in evaluating integrals involving Bessel, Legendre, confluent hypergeometric and other functions. The G-functions are generalizations of the E-functions, and their properties have been worked out with signal ability by Meijer. Their usefulness as an instrument of research has yet to be demonstrated. The final chapter of the first volume contains an account of the confluent hypergeometric function.

The second volume has chapters dealing with Bessel functions—naturally at considerable length—parabolic cylinder functions, incomplete gamma functions, orthogonal polynomials, spherical and hyperspherical harmonic polynomials, and orthogonal polynomials in several variables, and closes with a long account of elliptic integrals and functions. These should provide a valuable armoury for the research student. Here again something might have been done in the matter of notation. Nothing is gained by retaining the two Hankel functions $H_\nu^{(1)}(z)$ and $H_\nu^{(2)}(z)$ when one function only is required. Dougall's function $G_n(z)$ is simpler and more closely related to Macdonald's now generally accepted function $K_n(z)$. This latter function should be known as the modified Bessel function of the second kind—not of the third kind. One wonders, too, if the authors were unaware of the origin of the very general formula for the product of two Bessel functions at the top of page 48. It first appeared in the *Proceedings of the Edinburgh Mathematical Society*, Series 2, Vol. 2.

In spite of these criticisms, we congratulate the compilers on a great achievement. No university or scientific library will be complete without having these volumes on its shelves. THOMAS M MACROBERT

THE 'CHEMISTRY' OF ATOMIC NUCLEI

Nuclear Species

By Prof H E Huntley. Pp. xix+193. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1954.) 21s. net.

PROF. H. E. HUNTLEY has written an attractive elementary account of what may be called 'nuclear chemistry'. Just as the atomic shell model did for chemistry, the nuclear shell model is beginning to explain the more obvious facts of his subject. The author seems to think that a nuclear physicist should know his nuclei just as an inorganic chemist must know the properties of the elements, and of course there is everything to be said for this. But the subject is a wide one, namely, that covered by what is usually known as 'nuclear physics', while the book is mainly concerned with properties of the stable nuclei. It is true that there are references to radioactive nuclei, but many of their properties (for example, the characteristic features of β-emission) are not included. Since also the treatment of excited states of nuclei is rather sketchy, the subject-matter is largely confined to stable nuclei in their ground states. This subject is handled in a comprehensive and clear manner.

But Prof Huntley, in his preface, says that the book "is primarily intended for aspirants to University Honours". Personally, I do not think it would be practicable to introduce his subject-matter in so much detail into a crowded university honours course, because, after all, it is only a part of nuclear physics However, I would encourage any undergraduate or postgraduate student to read the book as part of his all-round education From this point of view it is perhaps a pity that the author has loaded the book with descriptions of more or less elementary background material (even, surprisingly, of the Michelson–Morley experiment) Such matters are not adequately dealt with from a student textbook point of view and might well have been taken as read In place, though the author's charts of isotopes are excellent, I would have liked to see the inclusion of a table of all the known nuclei (stable and unstable) such as the Seaborg–Perlman table of isotopes.

In spite of such criticisms, I am sure that Prof Huntley's book should be on the shelves of all physics libraries, since it undoubtedly contains a great deal of interesting material not available elsewhere in concise form H W. B Skinner

SHRUNKEN HEADS

Amazon Head-Hunters

By Lewis Cotlow. Pp. 208+17 plates (London Robert Hale, Ltd , 1954) 18*s* net.

THE author of this book is a New York insurance broker whose hobby is travelling in lands inhabited by primitive races. He is an expert photographer, and on his journeys he has sometimes had the aid of professional ciné-photographers His African film entitled "Savage Splendour" was a success Between 1940 and 1949 he made several expeditions to the north-west of the South American continent, from which rise the head-waters of the Amazon, and to country farther north around the Isthmus of Panama These are the areas inhabited by the Choco, Colorado and Yagua Indians, and include also the very isolated country of the Jivaro Indians, who are especially known for their custom of drying and shrinking the heads of their enemies The author has prepared commercial films relating to these journeys, and he has lectured much on his experiences This book gives a connected story and makes most interesting reading It contains a great deal of first-hand material which is of value to the anthropologist

While most of the tribes visited by the author are quite 'unspoiled' by contact with civilized peoples, the scientist will no doubt find his most interesting material in the sections which deal with the Jivaro Indians Mr Cotlow was able to become very friendly with several of their chiefs, and they informed him of the number of heads which they had taken during their lives He brings out forcibly the fact that the relatives of a man slain in battle are in honour bound to kill his killer and to shrink his decapitated head The relatives of this victim must retaliate in the same manner, so that inter-community warfare is almost continuous The author describes fully the method of shrinking a head Unfortunately, he did not actually see it carried out, since at the time of the raid he was stricken with dysentery He did see and photograph the victory-dance which followed the exploit. He also describes in detail the making of the fine blow-guns which are used by the Jivaros He frequently watched the use of the curare-tipped darts in killing animals. Birds died at once , monkeys survived between two and four minutes Larger animals were only irritated by these poisonous darts The author describes the use of the pincers of living ants for the purpose of suturing wounds He also describes an attack by the tiny, yet much dreaded, canero fish which embeds itself in the natural orifices of the body His comments on the food of the Indians are illuminating , for example, monkey stew he found not unacceptable, until he noticed a tiny hand floating in it During one of his trips to the natives he was made a blood-brother of the tribe, and it took him a week to remove the paint

This interesting and entertaining book is written modestly and without literary embellishment The author's sympathy with the Indians is apparent on every page E Ashworth Underwood

BIOCHEMISTRY OF CANCER

Biochemistry of Cancer

By Jesse P Greenstein Second edition Pp xiii+653 (New York Academic Press, Inc , London Academic Books, Ltd , 1954) 12 dollars

CANCER research and biochemistry are both wide and rapidly growing fields of study, so that Dr Greenstein has a wealth of material to discuss in this work He ranges from the study of theoretical chemistry in relation to structure of cancer-producing compounds to the structure of virus particles which can transmit malignant disease and the genetic factors in cancer

Dr Greenstein, who is chief of the Laboratory of Biochemistry in the National Cancer Institute Bethesda, Maryland, performed a most useful service to cancer research workers and biochemists when he published the first edition of this book in 1947. Since then many new facts have been discovered and hypotheses advanced, and these have been incorporated into the new edition by rewriting most of the book The work is divided into three main sections—the induction of cancer , attempts at control o tumour induction and tumour growth , and the properties of tumours

The processes of induction of cancer by viruses hormones, hydrocarbons, aromatic amines, aliphatic halogen compounds, metals, alkylating agents and radiations are all considered The section on contro of cancer induction and growth is still the smallest but it has increased in size relatively much more than the other parts of the book since the first edition The last section, dealing with the chemistry and biochemistry of tumours and tumour-bearing hosts occupies about half the book and is the field in which the author has made his own distinguished contributions This section is unique, as no other modern comparative account of the different properties o tumours is available

This new edition should be a great help to cance research workers , it would be even more valuable i the index were more complete and detailed Biochemists working in fields outside cancer research should find this monograph of interest

E Boyland

THERMONUCLEAR EXPLOSIONS AND THE WEATHER

By Sir GRAHAM SUTTON, C B E, F R S
Director of the Meteorological Office

THE poor weather experienced in the British Isles and generally in western Europe in the summer of 1954 came soon after the announcement by the United States Atomic Energy Commission that a series of thermonuclear explosions had taken place in the Pacific Perhaps not unnaturally, this coincidence caused speculation (unfortunately, often ill-formed and emotional) on the possibility of 'cause and effect'. The present article is an attempt to examine objectively if any grounds exist for suspecting a unique relationship between the man-made disturbances over the Pacific and the weather of mid-1954 in other parts of the world.

Such an investigation is difficult for a variety of reasons Weather is the first-order perturbation of climate and since (as shown below) the weather of 1954 did not exhibit, in the British Isles, any features that cannot be paralleled and even exceeded in past years, it follows that any effects attributable to the explosions must be of magnitude not exceeding that of ordinary weather-producing influences The detection of such additional effects, therefore, demands careful statistical analysis that cannot properly be attempted until several years have elapsed, so that existing climatic 'trends' (see below) can be recognized and eliminated An equally serious difficulty is that, so far, it is not known with certainty how many thermonuclear explosions occurred in 1954, or when and where they all occurred From Press reports, it is possible to make what is thought to be a reasonable estimate of the order of magnitude of the energy release in the largest of the Pacific explosions, but almost all other details are lacking

These factors, combined with present uncertainty concerning the mechanism of many fundamental atmospheric processes, such as the formation of depressions and the precipitation of water, make it mpossible to give a rigorous demonstration of the truth or falsity of the proposition that thermonuclear explosions were responsible for, or even contributed materially to, the poor summer of 1954 in western Europe At this stage the most that can be attempted s an examination of the plausibility of what is, for many people, a firmly held belief

Evidence from Meteorological Records

In the British Isles the summer (June, July and August) of 1954 was cool, wet and dull In England and Wales, in eighty-four years of comparable records here have been only six wetter summers, but in Scotland twenty-five summers gave a greater total ainfall No rainfall records were broken or even approached—1879 and 1912 had each about 4 in. of ain in excess of the total, for the whole country, of nearly 12 in for the past summer At Kew (for which station the records are unusually long and reliable) 1954 with a total of 9 5 in. for the summer alls far below the record year, 1903, in which 15 4 in ell in the three summer months In the present entury alone, 1924, 1927 and 1946 had each more wet days in summer than 1954

The season was decidedly cool, and of the past fifty-three summers only two, 1907 and 1922, had lower mean temperatures in England and Wales Sunshine also was lacking, and the only summer with a worse record in this respect since 1906 was 1912 (also a year with a wet summer)

In Western Europe, weather was generally cooler and wetter than usual, but there were notable exceptions June temperatures were above average in many parts, and in July, France had less than the normal rainfall In the United States and in the U S S R (so far as records are available) the summer was, on the whole, warmer than average and in the United States it was somewhat drier (July 1954 was, in fact, one of the hottest months ever recorded in the central United States) South and west Africa had wetter and cooler seasons than usual and Indian monsoon rains were generally above average Rainfall was also above average in Japan and Malaya

The world-weather picture of mid-1954 is thus complex, but not more so than usual. The most striking feature is that large areas of the globe experienced more cloud and rain and were somewhat cooler than would be expected from long-term averages

The climatological pattern for the British Isles in recent years has been examined by Dr J Glasspoole, head of the British Climatology Branch of the Meteorological Office, in a paper shortly to appear in the *Meteorological Magazine*. The climate of these islands, as indicated by long-term averages, is very stable, but over any period of years there are definite oscillations (called 'trends' by meteorologists) of variable length and amplitude Such major oscillations are clearly shown when yearly variations are minimized by plotting 10-year moving averages The curves so obtained show maxima and minima at irregular intervals, for example, the 10-year moving averages of summer temperature for England and Wales during 1901–53 begin well below the mean line, increase fairly rapidly and rise above the mean in the periods 1922–31 to 1929–38 and are now descending The corresponding rainfall curve shows a pronounced maximum in 1873–82, which has not been reached again, but the curve, after some smaller oscillations about the long-term mean, is now ascending The current trend in summer sunshine is also towards lower values

These results suggest (but do not positively demonstrate) that the weather of the past summer continues a general trend that has been indicated for some years past. This suggestion cannot be properly examined until future years have produced more observations, but at least it indicates the possibility that cool wet summers will not be infrequent for some years to come It should be pointed out, however, that such 'trends', although of great interest to the climatologist, are of little or no value as a basis for long-range forecasts, and it is possible for the summer of a single year (such as 1955) to be warm and dry without affecting significantly the general character of the current trend In the present connexion the analysis may be significant in that it suggests that the summer of 1954, although extreme, did to some extent conform to an existing pattern and therefore need not have been influenced by artificial causes

The anatomy of the pressure field during the summer reveals some interesting features. Two types of patterns dominated one in which depressions approached the British Isles from the north-west (this type was persistent in a period near the end of June and the early part of July) and another (chiefly responsible for the large rainfall totals in southern England in August) characterized by the approach of depressions from the south-west Examination of 5-day means for the northern hemisphere indicates that a pattern with three major long waves was established before the beginning of July and persisted through much of August

Present-day knowledge of the general circulation, and of the mechanism of the formation and steering of the large slow-moving disturbances of the atmosphere over the Atlantic, is inadequate to relate such patterns to isolated large displacements of air occurring in, say, the Pacific. However, the relative stability and persistence of the patterns do not suggest a unique connexion with explosions. Left to itself, the kinetic energy of an atmospheric disturbance is reduced fairly rapidly by eddy friction, and Brunt[1] has estimated that in these conditions the general circulation would practically cease in less than a week Press reports indicate that there must have been intervals of some weeks between the known explosions, and it may therefore be supposed that the direct effects of the trials would be felt as isolated bursts of bad weather with intervening settled spells Actually, the unsettled showery type persisted throughout the summer, and there were no well-developed spells of fine weather in the British Isles

Thus both the climatological and aerological evidence are unfavourable to the suggestion that thermonuclear explosions, so far as they are known to have occurred, ruined what might otherwise have been a fine summer. The weather experienced in the British Isles was well within the established climatic range, and taking all facts into account, it is evident that it would be exceedingly difficult, if not impossible, to establish a 'cause and effect' sequence on purely meteorological grounds What evidence exists points, in fact, to the opposite conclusion

Dates and Orders of Magnitude

The difficulties of direct investigation of the effects of thermonuclear explosions, intrinsically very severe, are enhanced by lack of information concerning the events. The earliest thermonuclear trial seems to have been that conducted at Eniwetok in November 1952, which was declared by President Eisenhower on March 12, 1953, to have been a full-scale 'hydrogen' explosion On August 20, 1953, *Pravda* stated that "a few days ago one of the types of hydrogen bomb was exploded" This was confirmed by the U S Atomic Energy Commission on the same day, and the actual date was given as August 12, 1953 , but no information has been published concerning the place of the trial or the magnitude of the energy release On March 1, 1954, the Atomic Energy Commission announced that an 'atomic device' had been detonated in the Marshall Islands, and on March 29, 1954, Admiral Strauss referred to this as a "thermonuclear device", adding that a second thermonuclear explosion had been set off on March 26 Finally, on May 13, 1954, Admiral Strauss announced the completion of a series of tests in the development of thermonuclear weapons , but the number and dates of the events have never been announced

It is seen from the above that the known thermonuclear explosions have extended over a considerable period of time, with presumably a maximum frequency in the spring of 1954 Statements by the U S authorities indicate that at least one explosion was about six hundred times as powerful as the Nagasaki bomb This indicates an energy release of the order of 10^{16} gm cal. Shaw[2] has estimated that the kinetic energy of an average cyclonic disturbance, 10 mb deep and 1,400 km diameter, is about 3 5 × 10^{16} gm cal , and Brunt (quoted by Shaw) has calculated that the kinetic energy of the general circulation of the atmosphere is of the order of 7 × 10^{19} gm. cal. Thus the energy release in what is thought to have been the most violent explosion to date is equivalent to the addition of one rather small depression to the atmosphere, or to an increase of the kinetic energy of the whole circulation by slightly more than one part in ten thousand, assuming that the whole of the energy released appears as energy of motion. Atmospheric turbulence has been estimated by Brunt to dissipate kinetic energy at about 1 gm. cal per square metre per second, so that those who seek support for the theory that the effects of the explosions were felt all over the world in increased cyclonic activity, lasting for many months, are faced with a difficult task Even in the case of the largest volcanic explosions, any strengthening of the general circulation is not detectable more than six months after the event[3] It seems that the only really hopeful line of support for such theories is to be found in the examination of subsidiary effects such as the action of dust, and that the direc dynamical consequences must have been confined to the vicinity of the trials

Possible Effects of Dispersed Debris

The theory that volcanic eruptions, by ejecting immense clouds of finely divided matter into the upper atmosphere, can cause notable changes in the amount of solar radiation reaching the surface of the earth and are usually followed by cool, wet weathe or even severe winters, was advanced by the late W J. Humphreys and given much prominence in hi well-known book "The Physics of the Atmosphere" Two possible examples taken from the climatic record of Great Britain are 1903, which was preceded by the eruption of Mt Pelée in 1902, and 1912, which coincided with the eruption of Katmai (Alaska) Both these volcanoes are well placed to cause pollution of the upper atmosphere over Europe Humphreys's theory has not found universal acceptanc among meteorologists and there is little direc evidence of notable climatic effects from the dus clouds. Thus Shaw[4], after pointing out that "th additional short-wave radiation that reaches a horizontal surface in consequence of the scattering b dust particles seems to go some way towards compensating the surface for loss of direct radiation o account of obstruction by the dust", states tha 1912 showed a more abundant supply of solar energy at South Kensington than did the years immediately preceding and following the eruption of Katmai.

The amount of debris thrown into the upper atmosphere by the Pacific explosions was almost certainly less (probably by several orders of magnitude) than that ejected in the Krakatoa explosions. There is no evidence of abnormal weather in England following this eruption, although the optical effects of the dust were evident all over the world. At Pavlovsk, the Katmai eruption may have been responsible for a reduction of about 20 per cent in the solar radiation, and Kimball's analysis indicates that the total radiation received on a horizontal surface at Mount Weather in the months following the same eruption was, on the whole, about 5 per cent below that of the following year. Brooks[5] concludes that the only appreciable climatic effect of volcanic dust is a general cooling; but it is obvious that such effects can be detected only with the largest eruptions. As solar radiation records generally show considerable 'noise', it seems likely that the effects of thermonuclear dust clouds on the radiation income of Europe will be difficult to detect and probably impossible to assess with any degree of confidence. So far, there has been no indication of any reduction of solar radiation in the British Isles that can be attributed to pollution arising from thermonuclear explosions.

Whether dust clouds of themselves can cause notable augmentation of precipitation is not easily decided. Orthodox meteorological theory excludes ions and all non-hygroscopic particles as nuclei of condensation because of the high relative humidity required. Although direct evidence is lacking, it is very unlikely that relative humidities greater than a fraction of one per cent supersaturation over a pure water surface are ever encountered in the free atmosphere[6]. Observational material accumulated to date points to sea salt as the principal nucleus of condensation, although the oxides of sulphur and nitrogen may play some part. The evidence is not entirely clear, but it is generally accepted by meteorologists that the air over a maritime country like the British Isles has always a sufficiency of nuclei of condensation of finite size for the formation of rain.

If a drop carries an electrical charge of q e.s.u. on its surface, the equilibrium vapour pressure is given by

$$\rho_w R_w T \ln\left(\frac{e}{e_s}\right) = \frac{2\sigma}{r} - \frac{q^2}{8\pi r^4},$$

where ρ_w is the density of water, R_w is the gas constant per unit mass of water vapour, T is the ambient temperature, e and e_s are the vapour pressure and saturation vapour pressure, respectively, σ is the surface tension and r is the radius of the drop. Johnson[6] states that even in thunderstorms, where the drops carry relatively high charges, the term which represents the effect of the electric charge is of negligible importance in the determination of the rate of growth of the droplet. It has not proved possible to compute a likely value for the charge on a drop encountering the radioactive cloud from a thermonuclear explosion several days, or weeks, after the explosion; but it is clear that unless very high charges are acquired, the rate of growth of droplets in the free atmosphere is not affected. The conclusion is thus that it is exceedingly unlikely that radioactive material, whether from a bomb or an atomic pile, can cause any significant increase in rainfall experienced over a large area. In particular, nothing like the classical cloud-chamber process can be envisaged because of the high degree of supersaturation needed.

The World Meteorological Organization is now endeavouring to collect information from member-nations about atomic explosions and climatic effects. How far this appeal has succeeded is not known, and it may be that in the light of further information some of the arguments given above may need revision. Even so, the present state of meteorological knowledge renders it unlikely that a firm conclusion can be reached; but so far the available evidence points to the conclusion that recent thermonuclear trials cannot be held responsible for any world-wide extremes of weather encountered in 1954.

---

[1] Brunt, D., *Phil. Mag.* (Feb. 1926).

[2] Shaw, W. N., "Manual of Meteorology", 2, 299.

[3] Brooks, C. E. P., and Hunt, T. M., *Meteor. Mag.*, 64 (1929).

[4] Shaw, W. N., "Manual of Meteorology" 3, 128.

[5] Brooks, C. E. P., "Climate through the Ages" (1949).

[6] Johnson, J. C., "Physical Meteorology" (1954).

ORIGIN AND AGE OF METEORITES

By PROF. HAROLD C. UREY, For. Mem. R.S.

Institute for Nuclear Studies, University of Chicago

BOTH privately and publicly (meeting of the American Association for the Advancement of Science, December 1953, and the Rome meeting of the International Union of Geodesy and Geophysics, September 1954) I have expressed the view that the ages of iron meteorites determined by the helium method are meaningless. Paneth and his collaborators[1] have developed most elaborate and careful methods for the determination of helium and uranium in iron meteorites. The first results were interpreted on the assumption that all the helium was radiogenic, and widely varying ages were secured. Bauer[2] and Huntley[3] pointed out that the helium might well have been produced by cosmic rays, and Mayne[1] showed that helium-3 was indeed present and hence that the helium was partially non-radiogenic in origin. Then subtraction of the estimated amounts of non-radiogenic helium made possible a corrected estimate of the ages from the remaining radiogenic helium. The ages so secured were small, namely, of the order of 10^8 years or less.

Uranium and thorium are exceedingly electropositive elements and they should not be present in the iron meteorites at all, assuming that Goldschmidt's theory for the distribution of elements between the silicate, troilite and metallic phases is correct. The standard free-energy changes for the two reactions

$$UO_2 + 2Fe = U + 2FeO$$

$$ThO_2 + 2Fe = Th + 2FeO$$

are 126.4 and 138 kcal. respectively at 2,000° K., which is some 200 deg. above the melting point of the iron–nickel alloy. The activity of the iron in the metal is about unity and that of the iron oxide in a silicate melt of meteoritic composition is about 0·13. Hence the ratio of uranium concentration in the metal to the uranium oxide concentration in the silicate melt should be

$$\frac{[U]}{[UO_2]} = K\,\frac{[Fe]^2}{[FeO]^2} = 10^{-13 \cdot 8} \times \frac{1}{0 \cdot 13^2} = 9 \cdot 4 \times 10^{-13}$$

The corresponding value for $\frac{[Th]}{[ThO_2]}$ is $3 \cdot 5 \times 10^{-16}$.

It is obvious that except for small amounts due to occlusion or very slight solubility of oxides in the metal phase, uranium and thorium should be much less abundant in the metal phase than in the silicate phase. It may be that their sulphides might be somewhat more stable and that these elements might be present in the troilite phase. One concludes that any uranium and thorium in the iron meteorites are in the silicate or sulphide inclusions. Hence radiogenic helium might escape from the iron meteorites along the fissures that are always present in these objects.

If the iron meteorites were formed by a collision between two asteroids some 10⁸ or so years ago, it might be assumed that in the collision which broke up the asteroids the iron melted and the radiogenic and cosmic ray helium formed up to that time was lost. Then the calculations on the ages from the cosmic and radiogenic helium could reasonably be made. But how could the Widmanstatten figures form, since the iron meteorites would cool rapidly and become ordinary iron–nickel steel? This series of events must be rejected because of this difficulty. Another supposition would be that in the collision the irons were not heated to high temperatures and thus retained their Widmanstatten figures, but that the radiogenic helium formed previously and after the time of break-up leaked from the meteorite because it was formed in the occlusions. Since we do not know what fraction of the radiogenic helium was lost, we cannot calculate the age. Paneth *et al.* suggest that the iron meteorites have lost their helium as they passed near the sun. This means that a particular meteorite had an orbit passing near the sun until a time equal to the age which they calculate. Then some close approach to one of the planets perturbed the orbit until the meteorite did not pass near enough to the sun to lose its helium. The Widmanstatten figures were presumably formed during the time of near approach to the sun, or these figures acquired in some earlier process were not destroyed during this time. Then the age records the time since the perturbation occurred. It seems possible that such a series of events occurred in a few cases; but it is most improbable that it occurred in every instance, and thus for most of the meteorites the two alternate courses of events or others must be assumed. While the excellent studies of Paneth and his co-workers are most interesting because of the facts which they present about the formation of meteorites and the effects of cosmic rays, I believe that it is very difficult to decide what event or events were recorded by the helium, uranium and thorium abundances.

At the December 1953 meeting of the American Association for the Advancement of Science, Dr. H. Craig pointed out that the iron meteorites form three rough groups on the basis of nickel content, and that two of these can be correlated with the two prominent groups of chondrites on the basis of equality of nickel content between the irons and the metal phase of the chondrites[4]. Also, plessite, kamacite and tænite, the iron–nickel alloys forming the Widmanstatten figures in iron meteorites, are found in chondritic meteorites[5]. It seems likely that the differentiation of the iron and stone meteorites occurred at the same time and in some closely related processes[6]. At least some metallic iron containing both kamacite and tænite and some crystalline silicate such as that of the achondrites was formed, presumably by melting and crystallization processes prior to the agglomeration of the chondrites. Many studies of these objects show that they have been formed by the agglomeration of fragments of silicates, drops of molten silicate glasses which have been only partly crystallized, and bits of iron–nickel alloys of the plessite, kamacite and tænite varieties. The bent bits of iron, broken crystals and the chondrules which were once molten drops indicate that the process was one of considerable violence, certainly sufficiently so to remove radiogenic argon from the potassium-containing minerals, which are generally among those of lowest melting points.

Recently, Wasserburg and Hayden[7] have shown by the potassium-40/argon-40 method that the ages of two chondrites, Forest City and Beardsley, are 4·6 and 4·8 × 10⁹ years respectively. These are the times since the radiogenic argon was removed from these objects, and they have not been melted or heated to temperatures of, say, about 1,000° C. during the past 4·5–5 × 10⁹ years. The time of formation of these objects was that of the origin of the solar system or earlier. Such ages depend critically on the potassium and argon analyses, which were made by isotope dilution methods at the University of Chicago and the Argonne National Laboratory under the supervision of Dr. M. Inghram and myself. The potassium analysis was checked by another method developed by Dr. G. Edwards and me[8]. These latter analyses show that the chondrites have a remarkably constant amount of potassium near 0·088 per cent. Potassium-40/argon-40 ages of two chondrites have been reported by Gerling and Pavlova[9]. These are given as 3 × 10⁹ years. Their analyses for potassium are 0·18 and 0·17 per cent, twice the average of Edwards's and Urey's analyses and much higher than their maximum value of 0·1024 per cent for the Beardsley meteorite. Whether the difference in ages is real, or due to errors in potassium analyses, or to loss of argon by heating during geological time is difficult to say, though I suspect that these chondrites, like the others, have smaller amounts of potassium than those reported, and hence their ages may indeed fall in the 4·5–5 × 10⁹ year-range. Patterson and Hayden[10] have found evidence from the ratio of lead-206 to lead-207 in the stones and irons for similar ages, and this means that the lead, which is chalcophile and is in the iron sulphide phase, and uranium and thorium, which are in the silicate phase, have not been separated by melting in this length of time. Since the fragmentation process which formed the chondrites was very energetic, as shown by the evidence that the chondrules were melted, argon must have been lost during the process. Hence this process occurred before the time of the recorded ages.

But the agglomeration into the solid bodies of the chondrites also took place at this time. Any bits of iron, broken crystals and chondrules moving in space near the asteroid belt would have been drawn to the sun in a short period of time by the Poynting–Robertson effect[11] and thus would not have fallen on the larger asteroids, for example, except for a limited period of time. Much of the differentiation of the meteorites by melting, crystallization, fragmentation and agglomeration took place during the formation of the solar system and not since then, and especially not in the past 10^8 years

Wahl[12] has suggested that the black chondrites are white chondrites which have been heated above the melting point of iron sulphide (~ 1,200° C.) The black veins of some chondrites have the same chemical composition as the lighter material adjacent to them and thus seem to have been heated by a slip process during the supposed asteroidal collision which produced them. It will be interesting to study the ages of these objects as well as those of the achondrites and stony irons by the potassium-40/argon-40 method as a means of determining the times of these heating processes. Some time ago, Prof. W. Wahl showed me a beautiful series of chondrites ranging from the very oose structure of Bjurbole type through the white and grey chondrites to the black chondrites, indicating different degrees of heating. Also the calcium-poor achondrites, which Urey and Craig suggested may be melted chondrites, show evidence of heating It will be interesting to secure ages of these objects as a means of estimating the times of these heating processes One hint in regard to the results to be expected comes from Wahl's[13] study of the polymict stone meteorites. Thus black chondritic material with small enclosures of white chondritic material is enclosed in grey chondrite in the Hainaut meteorite Other examples are given by Wahl It seems most ikely that all heating except that due to collision processes occurred before the conglomerates of the chondrites were produced But regardless of the esults of such experiments, the results obtained by Wasserburg and Hayden show that the principal differentiations occurred during, or perhaps even prior to, the formation of the solar system.

Kuiper[14] suggested that the melting processes which obviously have occurred in meteoritic material were produced by radioactive heating during the rst part of geological time after the planets were ormed. This seems not to be the case unless the olar system was formed longer than 4 5 × 10^9 years go. The exact time required for melting is in doubt, ecause of current uncertainties in regard to the osmic abundances of uranium, thorium and potassium. Hence the course of events on this assumption would be an accumulation at low temperature of ubstantial bodies of low conductivity, followed by a ong period (~ 10^9 years perhaps) during which they were heated by radioactive heating until they melted, and then an active brecciation by processes ncidental to the formation of the solar system some 5–5 × 10^9 years ago, which produced the chonrites, and finally no heating processes since then. his means that these asteroidal objects and the sun resumably must have been formed at the same me, that is, before the universe is currently assumed o have originated, some 5 0 × 10^9 years ago—a urprising conclusion for a star of Population I. But erhaps, as I have suggested[15], it may be that these bjects, which I called planetesimals, antedated the olar system. Or the universe has no age, as the roponents of continuous creation maintain. Or, it may be that the elements were synthesized or their bundances readjusted to some extent during the ormation of the sun, and nuclides of shorter halfves such as chlorine-36 or cæsium-135 heated these bjects In this event objects of considerable size formed very quickly after the origin of these elements. Or other heating processes occurred as I have suggested. But the simplest assumption is that the universe and solar system are older than we have thought, and that Population I stars are indeed old stars and not even only moderately old stars. Of course, simple assumptions are not necessarily true.

In summary, it seems probable to me that at least most of the meteorites, stones, irons and stony irons have not been heated markedly since the solar system was formed some 4 5–5 × 10^9 years ago, and that the processes by which they were formed were indeed part of the early history of the solar system. The ages of iron meteorites determined by the helium method are probably in error because of a leak of the radiogenic helium This helium was produced in silicate or sulphide (?) inclusions, and hence leaked more or less rapidly along fissures which are present in these objects

[1] Paneth, F A, *et al*, *Geochim et Cosmochim Acta*, 3, 257 (1953)

[2] Bauer, C A, *Phys Rev*, 74, 225, 501 (1948)

[3] Huntley, H E, *Nature*, 161, 354 (1948)

[4] Urey, H C, and Craig H, *Geochim et Cosmochim Acta*, 4, 36 (1953)

[5] See, for example, the La Lande, New Mexico, chondrite Beck, C W, Stevenson, jun, R G, and LaPaz, L, *Pop Astro*, 59, No 2, 93 ff (February 1951)

[6] For a suggested course of events see Urey, H C, and Craig, H, *Geochim et Cosmochim Acta* 4, 72 (1953)

[7] Wasserburg, G J, and Hayden, R J, *Phys Rev* (in the press)

[8] Edwards, G, and Urey, H C, *Geochim et Cosmochim Acta* (in the press)

[9] Gerling, E K, and Pavlova, T G, *Doklady Akademii Nauk, U S S R*, 77, 85 (1951)

[10] Patterson, C, and Hayden, R, *Phys Rev* (in the press)

[11] See Wyatt, jun, S P, and Whipple, F L, *Astrophys J*, 11, 134 (1950)

[12] Wahl, W, *Geochim et Cosmochim Acta*, 2, 91 (1952)

[13] Wahl, W, *loc cit*, see illustrations on pp 93 and 94 particularly

[14] Boston meeting of the Amer Assoc Adv Sci, December 1953

[15] Urey, H C, *Astrophys J*, Supp 1, 172 (1954)

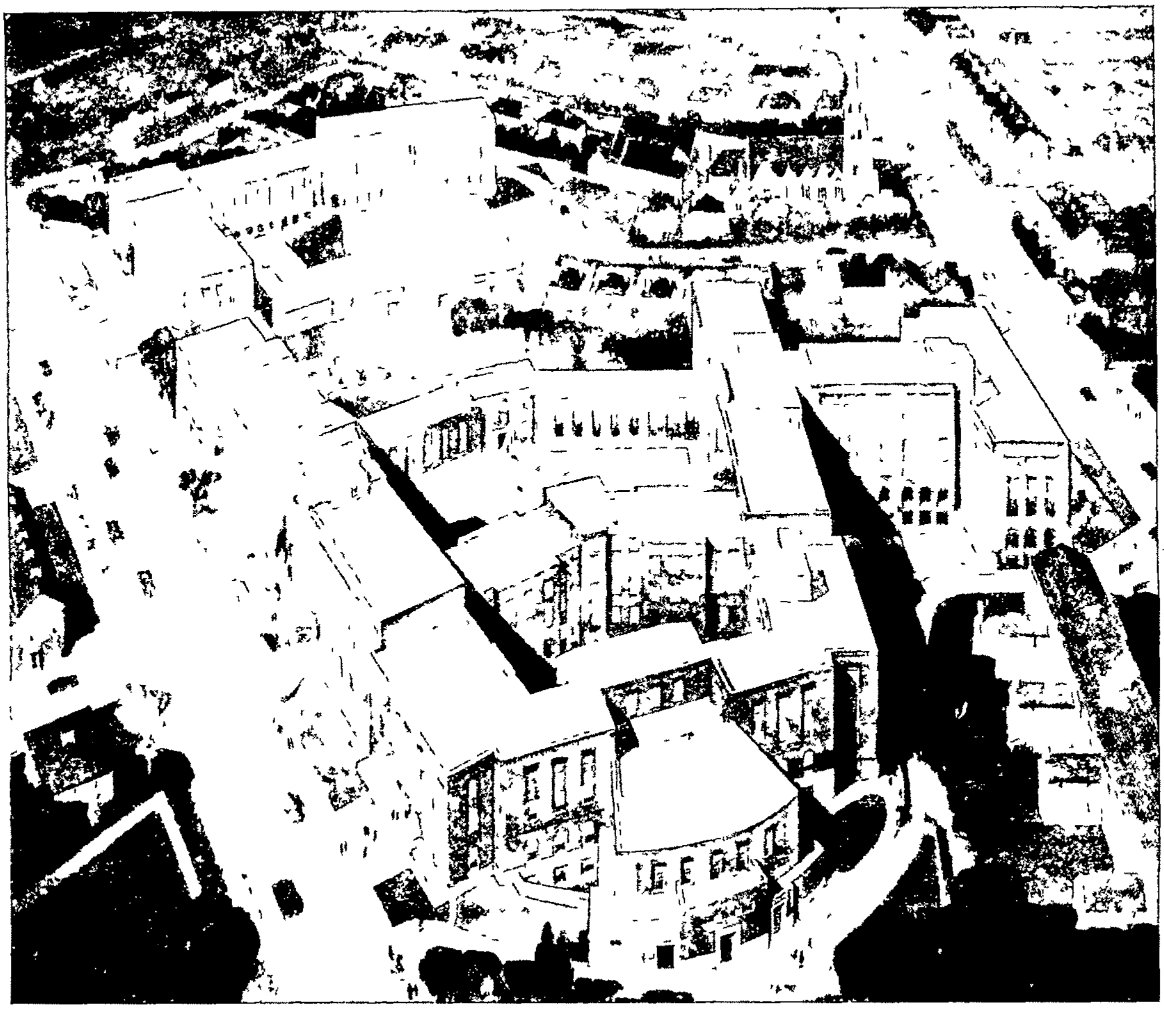
HIGHER TECHNOLOGICAL STUDIES IN NORTHERN IRELAND

By Dr ERIC ASHBY

Vice-Chancellor, The Queen's University, Belfast

IN December 1954 the Royal Assent was given to a Bill in the Northern Ireland Parliament which enables a new experiment to be made in the organization of higher technological education. Hitherto, higher technology has been divided between the Queen's University of Belfast (which concentrated upon civil engineering) and the Belfast College of Technology, which provided, among other subjects, for mechanical, electrical, and aeronautical engineering and chemical technology The University's Faculty of Applied Science was, at it were, a guest in the laboratories of the College of Technology (an arrangement not unlike that which exists in Manchester), and the staff were officers of the Local Education Authority

After long and friendly negotiations between the University and the Corporation of Belfast, the conclusion was reached that it would be undesirable in a small Province with a population of 1 3 millions to duplicate facilities for higher technological education in the University and the City. It was agreed, too, that higher technological education, including Higher National Certificate work, should be separated from more modest forms of technological education. The



Architect's sketch (Messrs. Lanchester and Lodge) of the Science and Engineering Buildings now being erected at the Queen's University, Belfast

solution to the problem seemed to be to set up first-rate facilities for teaching and research in higher technology, and to give both the University and the City access to these facilities. This has been accomplished in the following way: (1) Beginning with mechanical and electrical engineering, the University will appoint all teaching staff concerned with work in the Faculty of Applied Science at university salary rates and on the F.S.S.U. (2) Some (but not all) posts on the teaching staff will include obligations to Higher National Certificate students, and the City will contribute to the University part of the salaries of these posts. Other posts may be concerned solely with Higher National Certificate work: these will remain under the local authority. The control of the Faculty of Applied Science will, of course, lie completely with the University.

The Departments of Mechanical and Electrical Engineering, at present located in the College of Technology, will move ultimately to a building (shown at the top left-hand corner of the accompanying architect's sketch) in the new science and engineering site of the Queen's University. The main block of new buildings on this site is at present in construction and will be ready for occupation in 1958–59. The block facing the road on the left is to accommodate civil (and temporarily electric engineering, the block facing the road on the rig is to accommodate botany and zoology, and t intervening block and two of the three cross-win are to accommodate chemistry. The third cross-wi (a single-story building) is to accommodate t Aeronautics Department endowed by Messrs. Sho Brothers and Harland, together with a hydrauli laboratory. A branch of the University Librar containing sections on engineering, chemistry a the biological sciences, will be accommodated in t building.

These new buildings are less than five minut walk from the centre of the University, and t Senate has therefore made no provision for meals student common rooms in the buildings, in the ho that science and technology students would there be persuaded to meet students from other facultie at least at meal times. The size of the buildings sufficient to accommodate adequately the prese numbers of University students: some 380 science, 150 in first-year medicine and agricultu and 460 in applied science and technology, togeth (ultimately and when the second block is complet with some 500 students taking Higher Nation Certificate.

CARL FRIEDRICH GAUSS AS A PHYSICIST

By Dr N. DAVY
University of Nottingham

THE name of Gauss is worthy to stand beside that of Newton and Archimedes. Born on April 20, 1777, the son of a bricklayer at Brunswick, Germany, he early displayed great mathematical ability. In 1807 he became director of the new astronomical observatory at Gottingen, and professor of astronomy in the university there. Working hard and continuously, not seeking new positions, and seldom leaving his observatory, he eventually died there on February 23, 1855 Space will not permit the analysis of many of his 124 memoirs, all significant, catalogued by the Royal Society, and his biography must also be sought elsewhere[1,2]. In the first part of his life, Gauss devoted himself in turn to the theory of numbers, algebra, general analysis, astronomy and geodesy His mighty works in these subjects were described long ago by able pens[3-5] The purpose of the present article is to survey briefly Gauss's work in physics

About the year 1831, when Wilhelm Eduard Weber became professor of physics at Gottingen, Gauss became interested in terrestrial magnetism The great problem then was—as it still is—to find the source of the earth's permanent magnetic field Halley (1692), following on the work of Gilbert (1600), had suggested that the field might be ascribed to a set of four magnetic poles. Some meagre data to test this had been accumulated by 1831, when philosophers were measuring, at irregular times and at a few scattered places, the three so-called elements of the terrestrial field These were the angle of variation, now called declination, the angle of inclination or dip, and the intensity of the field The venerable Humboldt, both by precept and example, emphasized the need for measuring the third element, as well as the others, with the utmost precision.

Humboldt and Arago were the first to establish magnetic observatories, in buildings free from iron In 1833 Gauss and Weber constructed an improved observatory of this type at Gottingen, in which the declination apparatus, unifilar and bifilar magnetometers were all invented by themselves. This observatory and the procedure adopted therein soon became a model for others throughout the world Gauss's first memoir on terrestrial magnetism was written in Latin, in the grand classical manner of Gilbert and Newton It was called "Intensitas vis magneticae terrestris ad mensuram absolutam revocata" (1832) Improving on the work of Poisson (1828), he here introduced his method of measuring *H*, the horizontal component of the earth's field The same paper also contained Gauss's method of proving experimentally the law of inverse squares, which at first assumes a law of the inverse *n*th power and goes on to show that *n* is equal to two A third manifestation of genius, in the same memoir, was the introduction of absolute units into physics. As measured at Gottingen, at 5 p.m on September 18, 1832, the value of *H* was found to be 1·782088, which Gauss only claimed to be accurate as far as 1 7821, in terms of the millimetre, the milligram and the second, as units of length, mass and time In the middle of such researches, Gauss and Weber (1833) constructed what has been called the first practical electro-magnetic telegraph, using wires connecting the astronomical and magnetic observatories at Gottingen The distance was about 3,000 ft

The name 'gauss' was first fittingly bestowed on the unit of magnetic intensity More recently, it has been replaced in that connexion by the term 'oersted', and the gauss is now the unit of magnetic induction, but numbers of physicists and engineers, reluctant to change with the fashion, persist, in private, in calling the unit of magnetic intensity a gauss, a name for which they have acquired a certain affection

To procure accurate and extensive data so that a proper theory of terrestrial magnetism could be developed, Gauss, from 1831 onwards, organized a Magnetic Union of observatories. At places throughout Europe, daily measurements of the three elements were made at the same moments and at the same regular intervals. By the efforts of Sabine and Lloyd, and following a letter by Humboldt (1836) to the Duke of Sussex, then president of the Royal Society, the British Government was persuaded to assist, very heartily and effectually, by erecting magnetic observatories at home and in the Colonies A special expedition of two ships, the *Erebus* of 370 tons and the *Terror* of 340 tons, under Ross, was sent to the Antarctic in 1839, with the primary object of making magnetic measurements in a region concerning which earlier information was very scanty. Other governments, especially that of Russia, gave their support, and in 1840 it was reported that thirty-two new observatories were established, or nearly so. For the sake of comparison it may be noted that in 1940 about seventy-five magnetic observatories were in operation, some in polar regions, not only measuring the elements at regular intervals, but also making continuous recordings of their fluctuations, now called 'variations'.

We now turn to Gauss's theoretical work. He had no theory of magnetism itself. He was concerned with terrestrial magnetism, the phenomena of which may be divided into the permanent main field and its variations, daily, monthly, annual, secular and non-recurrent (magnetic storms).

Neglecting the variations, in the memoir "Allgemeine Theorie des Erdmagnetismus" (1838), Gauss's purpose was to discover the law or formula which accounts accurately for the permanent magnetic potential and field everywhere on the earth's surface. The theoretical tools were at hand, thanks to Laplace and Legendre Gauss assumed that the potential, at any point on the earth's surface, was a solution of Laplace's equation He assumed also that the field was wholly due to sources inside the earth, and that the potential *V* could be written as the convergent series

$$V = S_1/r^2 + S_2/r^3 + S_3/r^4 + S_4/r^5 + \ldots$$

terms after the fourth being negligible. Here *r* was the distance of the point from the centre of the earth, and S_1, S_2, S_3, S_4 were surface harmonics, functions of the latitude and longitude of the point. The first term could be regarded as due to a uniform magnetization of the earth, or to a small magnet placed at the centre The other terms could not be interpreted physically. S_1, S_2, S_3 and S_4 were expressed in terms of twenty-four constants and trigonometrical functions of the latitude and longitude. This could not be done accurately with the older observations, and Gauss acknowledged that it was the publication in

1838 of Sabine's tables and chart of lines of equal total intensity, in the seventh report of the British Association, which inspired him to complete the laborious task. He also used the inclination (dip) chart by the German, Horner, and the declination chart of Barlow. Gauss then tested his formula by calculating fields at new points, and also the positions of the terrestrial magnetic poles. These last he predicted, in 1838, to be near 73° 35′ N, 95° 39′ W., and 72° 35′ S, 152° 30′ E, respectively, long before Amundsen (1903–6) found the North Pole to be at 71° N, 96° W, and the Discovery expedition (1902–4) found the South Pole at 72° 50′ S., 156° 20′ E. Thus Gauss laid a firm foundation for the theory of terrestrial magnetism on which Schuster, Gunn and others have built Using the better observations of 1885, Neumayer recalculated the twenty-four constants. Schmidt (1889) found that 1 per cent of the field was due to external sources Later still, in 1923, Bauer found that 3 per cent was due to a potential arising from external sources, 94 per cent to a potential arising from internal sources and 3 per cent, of non-potential origin, to electric currents in the atmosphere, but this last result is disputed by some authorities. Chapman has shown that about 72 per cent of the diurnal variation is due to external, and 28 per cent to internal sources The quality of Gauss's work is indicated by the following comment by Clerk Maxwell "Gauss, as a member of the German Magnetic Union, brought his powerful intellect to bear on the theory of magnetism, and on the methods of observing it, and he not only greatly added to our knowledge of the theory of attractions, but reconstructed the whole of magnetic science as regards the instruments used, the methods of observation, and the calculation of the results, so that his memoirs on Terrestrial Magnetism may be taken as models of physical research by all those who are engaged in the measurement of the forces in nature".

Maxwell's reference to attractions probably relates to Gauss's memoir, "Allgemeine Lehrsatze in Beziehung auf die im verkehrten Verhaltnisse des Quadrats der Entfernung wirkenden Anziehungs- und Abstossungs-krafte" (1840) These theorems relate to gravitation, electrostatics and magnetism. Among them we find that celebrated theorem, Gauss's theorem *par excellence*, showing that the total normal outward flux of force over a closed surface is 4π times the electric charge or magnetic pole-strength enclosed, or $4\pi G$ times the mass enclosed.

Much of Gauss's work in pure mathematics has contributed, since his time, to advances in electricity and magnetism. For example, in order to calculate the magnetic field of a two-dimensional pole-piece the cross-section of which is a curvilinear triangle, and the sides of which are circular arcs, one must first use Gauss's concept of a conformal transformation to change the edge of the triangle into the real axis of another plane This is done by the aid of Gauss's hypergeometric equation, which is solved by Gauss's methods.

Turning to optics, we find another manifestation of Gauss's power in the memoir "Dioptrische Untersuchungen" (1840). Here the concept of principal points was introduced, a concept which reduced the laborious mathematics of thick lenses and sets of coaxial lenses almost to the easy algebra of single thin lenses. Gauss's ideas were extended in 1845 by Listing, who discovered nodal points. Along with this may be mentioned, as a bagatelle of genius Gauss's optical invention called a heliotrope (1821) based on the law of reflexion of light by plane mirrors and useful in geodetic work for sending signals o sunlight to distant points

Like Newton, Gauss wrote a "Principia", not bound book, but a memoir called "Principia generali Theoriae Figurae Fluidorum". To Gauss this was jus a trifle, but it alone would have made the name of lesser man. The principle of virtual work and th calculus of variations were applied to a liqui standing in a capillary tube. The differential equatio of the free surface and Young's equation relating t angles of contact were deduced in an elegant manne free from a defect which vitiated Laplace's treatmen of the same topic.

Gauss never rushed into publication. As the year passed, he became more and more averse to it o indifferent to priority. Von Waltershausen tells u that in 1831 Gauss suddenly took up crystallography quickly mastered it in a few weeks and as suddenl relinquished it. His unpublished note-book shows tha he had largely forestalled the later work of Miller.

There is no space to relate all Gauss's persona peculiarities, his virtues and failings, his literar style, his veto on the taking of notes of his lecture by his students, his adverse opinion on Abel's firs great paper, and so forth. We trust that enoug evidence has been adduced to show that, in bot theoretical and experimental physics, Gauss was a great a master as in mathematics and astronomy and that, as Johnson said of Goldsmith, he touche nothing which he did not adorn.

[1] von Waltershausen, W Sartorius, "Gauss zum Gedächtniss" (Leipzi 1856)

[2] Tucker, R, *Nature*, **15** 533 (April 19, 1877)

[3] Prasad, G, "Some Great Mathematicians of the Nineteenth Century" 3 vols (Benares, 1933), see vol 1, pp 1–67

[4] Bell, E T, "Men of Mathematics", pp 250–305 (London, 1937)

[5] *Proc Roy Soc*, **7**, 589 (1856)

OBITUARIES

Prof. G V Anrep, F.R.S

Prof. Gleb Vasilievitch Anrep, who died Cairo on January 9, was one of the outstandin physiologists of his generation. He was born in St Petersburg in 1891, the son of Basil Anrep, professor o pharmacology in the Military Medical Academy, wh discovered the local anæsthetic action of cocaine, an who was of Swedish extraction. Gleb Anrep studied a the Military Medical Academy, where he came unde the compelling influence of I. P. Pavlov, commencin research work on the conditioned reflexes while stil a student. He was not yet qualified when 'Iva Petrovitch' sent him in the vacation of 1912 to visi Starling, in order to demonstrate to him the effect o vagus stimulation on the secretion of pancreati juice, and to acquire the method of preparing pan creatic secretin. He already spoke tolerable English and soon became fluent during that and two simila visits in the next two years, when he worked unde Starling at University College, London. The thir visit was curtailed by the outbreak of war in 1914 when he returned to Russia, completed his quali fications, and joined the Army, in which he serve until 1917 as a medical officer. He then returned t Petrograd, studied at the Institute of Experimenta Medicine, and took his M D Being opposed to th Revolutionary Government, he joined the ant

Bolshevik forces of General Denekin in 1918, remaining with them until their defeat, after which, with the help of Starling, he came to England, and worked as a lecturer at University College until 1926, taking a D.Sc He became naturalized in 1925, and was made a Fellow of University College in 1928.

In 1926 he moved to Cambridge, as lecturer in physiology, was awarded an M A., and in 1928 was elected a Fellow of the Royal Society.

In 1931 he accepted the chair of physiology at the Fuad I University, Cairo, in succession to Prof W. H. Wilson, and remained there until a short time before his death.

Anrep was an outstanding experimental physiologist of the classical type, imbibing his inspiration, through Pavlov and Starling, largely from the German school of Ludwig and his contemporaries His first loyalty was to 'Ivan Petrovitch', whom he revered and imitated largely, and to the land of his birth, the exile from which he greatly deplored. His second loyalty was to Starling, and to England, to both of which he owed so much. Perhaps a third was to Egypt, the deserts of which he explored with characteristic intrepidity and enthusiasm, having acquired a good knowledge of Arabic, and always having had a taste for adventure

His physiological work fell into two main categories in Russia, on the conditioned reflexes , and in England and Egypt, on circulatory problems. His first paper in the *Journal of Physiology*, in 1912, showed that the rise of blood pressure which followed when the splanchnic nerve was stimulated was in part due to the release of adrenaline. He was made a member of the Physiological Society in 1913, and contributed many papers to that and other journals, on such subjects as the coronary circulation, pancreatic and salivary secretion, the pulmonary circulation, cardiac reflexes, tissue histamine, and the peripheral circulation.

All his work was technically first-class , he had a terrifying capacity for work, was a quick and skilful, but rather temperamental, operator, and had a great knowledge of the literature of his subject

As a person, Anrep was engaging, buoyant, dynamic, with quick enthusiasms and Slav introspectiveness , and, on occasion, as when an experiment failed, he was capable of acute self-depreciation. He had great gifts as a raconteur and as a lecturer of an unusual type. He was a keen collector of apparatus and of postage stamps

He had one son by his first wife, Olga , by subsequent marriages no issue. C. LOVATT EVANS

Mr A. S. Ramsey

ARTHUR STANLEY RAMSEY, senior Fellow of Magdalene College, Cambridge, died at Cambridge on December 31

He was born at Hackney in 1867, the eldest son of the Rev. Averell Ramsey, a well-known Congregational minister. He was educated at Batley Grammar School and Magdalene College, Cambridge, where he graduated fifth wrangler in 1889 After seven years as mathematics master at Fettes College, he returned to Magdalene in 1897 as Fellow and lecturer in mathematics, and held the latter post until his retirement from active teaching in 1934. When the office of University lecturer was instituted in 1926, Ramsey was one of the first to be appointed, and he continued in office until his retirement under the age limit in 1932.

Ramsey would have been the first to disclaim originality in his contributions to mathematics His great gift was as a teacher, particularly of applied mathematics, and he had an especial understanding of the needs of the average student. He soon realized that there was a great lack of systematic text-books adapted to the course of study, and he set himself with indefatigable industry to fill this gap. In the course of years a truly remarkable series of text-books flowed from his pen. His published works are "Modern Plane Geometry" (Richardson and Ramsey), "Hydromechanics" (Besant and Ramsey), "Hydrodynamics", "Elementary Geometrical Optics", "Dynamics" "Statics", "Hydrostatics", "Electricity and Magnetism" , and "Introduction to Newtonian Attraction" All these books are marked by clear thinking, orderly presentation and a wealth of illustrative examples, and most of them, despite great developments in mathematical theory and method, have maintained a steady and deserved popularity His lectures were equally clear and systematic, and, in private teaching, there were few questions to which he would not at once produce the answer from among his carefully filed manuscript notes.

In addition to his mathematical work, Ramsey took a very active part in college and university administration. He was successively bursar, tutor and president (that is, vice-master) of Magdalene, and he was a member of the Financial Board of the University of Cambridge for more than twenty years. He had a special interest in religious matters and particularly in the affairs of the Congregational Churches He was for many years a member of the Council of the Congregational Union of England and Wales, and gave very valuable help to Cheshunt College, Cambridge, as a governor and for nine years as chairman of the governors

Ramsey was a man of uncompromising integrity, and he was possessed by a tremendous sense of duty Though he could be formidable indeed in his condemnation of the culpably second-rate, kindliness was never far absent, and in his later years it was his dominant characteristic. In his retirement he could be relied upon to delight his listeners with a seemingly inexhaustible fund of reminiscence, told with inimitable humour. He made a lasting impact upon the life of his College, and both there and elsewhere he will long be remembered as a teacher and as a wise friend. His private life was clouded by two great tragedies, stoically endured His wife, whom he had married in 1902, lost her life in a motor-car accident in 1927, and three years later came the lamentably early death of his elder son, the brilliant F. P Ramsey, Fellow of King's and author of "Foundations of Mathematics". He is survived by his younger son, A. M. Ramsey, Bishop of Durham, and by two daughters D W BABBAGE

Mr. Edwin Grey

ONE of the last links with the Rothamsted of Lawes and Gilbert's time was broken when Edwin Grey died on January 30 at the age of ninety-five. Young Ted Grey went to the Rothamsted Laboratories in 1872 when he was thirteen years old, and with other boys was trained to carry out the botanical analysis of the hays from the Park Grass plots He was soon marked out as a careful and reliable worker, and as time went on he took part in the classical experiments on soil fertility and animal feeding of the second half of Gilbert's reign. For many years Grey was field superintendent in charge of the famous field plots, and never were they better cared for.

Outside his work Grey entered into the social life of the village and Laboratories with great zest, and his unusually clear memory of scenes and dialogue enabled him to record, in his later years, the human story of the Laboratory and its surroundings in two most readable books. One of these, "Reminiscences of the Rothamsted Laboratories, Staff, and Experimental Fields", gives a striking and vivid picture of the original Rothamsted and its great and also its humbler personalities. The other, "Cottage Life in Hertfordshire Village", portrays in almost photographic detail the daily lives and customs of a smal rural community in the last quarter of the nineteent century.

On his retirement in 1922 after fifty years service Edwin Grey was presented with an address bearing many of the best known names in agriculture. He maintained his interest in Rothamsted affairs for the rest of his long life. Seldom did one visit him withou coming away with some interesting sidelight on the Rothamsted story. He was the last survivor of the old order.

H. V. Garner

NEWS and VIEWS

University College of Rhodesia and Nyasaland

The announcement was made on February 15 that H.M. the Queen has, by order in Council dated February 10, approved a grant of a Royal Charter to the University College of Rhodesia and Nyasaland. The Federal Prime Minister, the Right Honourable Sir Godfrey Huggins, was present at the Council. Furthermore, H.M. Queen Elizabeth, the Queen Mother, has accepted the office of president of the College. As we recorded more than eighteen months ago (*Nature*, 172, 1, 1953), the Carr-Saunders Commission on Higher Education for Africans in Central Africa recommended that the College in which it was interested should be granted complete autonomy and that it should be established by Royal Charter. The news that this has now been done will be pleasing to all who wish well of the experiment now being made in higher education in Central Africa. Reference has been made to this experiment in these columns from time to time (see *Nature*, January 29, p. 181), and the granting of a Royal Charter to the new university institution is indeed welcome. The news that Queen Elizabeth, the Queen Mother, who laid the foundation stone of the College during her visit to Central Africa in 1953, has agreed to become the first president of the College will also be received with pleasure. It is one more indication of the serious interest which the Royal Family takes in university education.

University College of the West Indies

The Jamaica Sugar Manufacturers' Association is to make a contribution to the funds of the University College of the West Indies in response to an appeal made by the Chancellor, Princess Alice, Countess of Athlone. The gift will take the form of 8*d*. a ton on all 'quota sugar' sold during the next seven years. Over this period, the contribution is expected to amount to £75,000. Caroni Ltd., Trinidad, the British Guiana sugar producers and the West India Sugar Company are also to respond to the appeal.

International Conference on the Peaceful Uses of Atomic Energy

Dr. H. J. Bhabha, director of the Tata Institute of Fundamental Research, Bombay, and chairman of the Indian Atomic Energy Commission, will be president of the United Nations Conference on the peaceful uses of atomic energy which opens in Geneva on August 8. Prof. Walter G. Whitman, head of the Department of Chemical Engineering at the Massachusetts Institute of Technology, will be secretary-general of the conference. In this capacity, Prof Whitman will serve as an officer of the U.N. Secretariat, and he will be assisted by a three-man U.N. working party consisting of Ralph J. Bunche and Ilya S. Tchernychev (U.N. Under-Secretaries), and Dr. Gunnar Randers (special consultant to th Secretary-General, Dag Hammarskjold, in matter relating to the conference). Eighty-four countrie have been invited to attend the conference. Mr. Hammarskjold said the nominations were made in accordance with the views of the seven-nation advisory committee drawing up plans for the conference. He will appoint six vice-presidents from nominees to be designated by Brazil, Canada, France the Soviet Union, the United Kingdom and the United States, which with India constitute the advisory committee; India is, of course, providing the president. There will also be a chairman and a *rapporteur* for each of the sections into which the conference will be divided for working purposes. These officers will be appointed by the Secretary-General before the conference opens. They will be selected from scientists eminent in the relevant fields and equitable geographical distribution will be taken into account.

After a preliminary address by Dr. Bhabha the conference will open by considering the world' estimated power requirements in some fifty year time, in order to set the stage for discussion o the effect of nuclear energy on the world powe problem. The agenda is divided into the following main subjects: need for a new power source; the role of nuclear energy; the building of a nuclea energy enterprise; health and safety aspects o nuclear energy; production and use of isotopes; problems relating to large quantities of radioactive substances. These will be considered in plenary session. In addition, section meetings will be held on such topics as reactors, biological and medical questions, and the application of isotopes to research and industrial problems. All subjects must be dealt with and presented only from the scientific and technical points of view. Papers must reach the Secretary-General not later than July 1; their titles, accompanied by an abstract not exceeding 500 words, should be submitted by May 15. Each country and specialized agency attending may send up to five representatives including, to the extent possible, individual experts competent in the atomic energy field; they may be accompanied by as many advisers as necessary. All meetings will be held in public, and will be interpreted in four languages

English, French, Russian and Spanish. As the conference will last only twelve working days, there will not be time for all papers to be presented orally. The choice of those to be read to the conference, in full or in part, will be made by a panel of qualified scientists to be designated by Mr. Hammarskjold on the advice of the advisory committee. Papers which are not presented orally will still be considered part of the conference, and will be included in its published proceedings.

Public School and Grammar School Boys for Industry

FOLLOWING the pamphlets recently issued on careers for university graduates in industry and directing the attention of industry in Britain to the growing importance of the universities as a recruiting ground for the ablest talent in each generation of school-leavers (see also p. 313), the Education Committee of the Federation of British Industries has now prepared a further pamphlet on the recruitment and training of the public school and grammar school boys in industry (pp. 12. Fed. of British Industries, London, 1954. 1*s*.) The pamphlet suggests that industry is in danger of neglecting an important source of managerial talent, and it makes detailed proposals as to the way in which firms able to offer posts suitable for public school and grammar school boys could summarize information regarding such posts and training on a standard index card for distribution to the appropriate schools. This distribution could be made direct to any schools with which the firm has already established contact, or with the co-operation of the Central Youth Employment Executive and the Public Schools Appointments Bureau.

The pamphlet points out that educational changes since the Second World War have led to many more grammar school boys in Britain remaining at school until they are seventeen or eighteen, while to-day 17 per cent of the total number of boys in the secondary schools are educated in grammar schools compared with 11.5 per cent in 1938. The selection procedure appears to be reasonably effective and, broadly speaking, the best intellectual talent in the secondary schools of England and Wales is to be found in the grammar schools, and, in Scotland, in the senior secondary school. Accordingly, industry can no longer count on recruiting from the elementary school leavers a sufficient number of those possessing the intellectual capacity and character demanded of foremen, departmental superintendents, managers or directors. Since at present 18 per cent of grammar school boys leave at 15, 48 per cent at 16, and 34 per cent between 17 and 19, there is still a large proportion of them, and of public school boys, available for recruitment at an age when industry is in direct competition with the Civil Service and other professions. Schoolmasters, in general, are probably less familiar with the prospects in industry, and the pamphlet is designed to dispel lack of knowledge which is leading industry to misuse valuable recruits.

Metallurgical Developments at Swansea

METALLURGY is an applied science, and in the words of Prof. R. Mehl is "a composite of learning and of abilities-to-do". As a university subject, like medicine, it is based on the pure sciences, which form the main part of the curriculum in the intermediate and subsidiary years. The reduction of metal from ore has been receiving a great deal of scientific study, but it is felt that the manipulation and utilization of the reduced metal itself requires increased attention' and in the widest field. Metallic parts for modern structures frequently involve expensive engineering operations, but by the co-operation of the metallurgist, the engineer and the physicist, metallurgical short-cuts may be provided. A scientific study of fabrication processes on a suitable scale may cure existing troubles and lead to improved techniques. This involves a type of physical metallurgy which can be called 'fabrication metallurgy'. It would cover welding and joining, precision casting, extrusion, powder metallurgy and mechanical deformation. The Steel Company of Wales and Richard Thomas and Baldwin, Ltd., have together made a munificent gift, totalling £100,000, to the University College of Swansea to develop work along these lines. Certain portions of the existing courses will be amplified, and students may be able to select alternative lines of study in their last year. The introduction of post-graduate courses is being considered. Laboratory extensions are in hand and research fellowships are contemplated. A professor of physical metallurgy will be appointed within the existing Department, to deal with the teaching and research which this development involves.

Charles Blachford Mansfield (1819–55)

A PIONEER in the aniline industry, Charles Blachford Mansfield, died one hundred years ago on February 26, 1855, a martyr to science. He was born at Rowner in Hampshire on May 8, 1819, and was educated at Winchester and Cambridge, where he took his B.A. degree in 1846. At the newly founded Royal College of Chemistry in London he became the favourite pupil of the superintendent, August Wilhelm von Hofmann, under whose direction he found coal-tar naphtha to be an abundant source of benzene. Benzene had lately been found in coal-tar and named by von Hofmann. By freezing a carefully fractioned sample of coal-tar naphtha, Mansfield in 1849 obtained with the aid of simple dephlegmators a pure benzene distilling below 100° C. which was a prerequisite for the aniline industry. In a pamphlet, "Benzol, its Nature and Utility", he mentioned that a peculiarly brilliant light could be produced by charging air with its vapour. During the 1849 cholera epidemic he advocated a pure water supply for Bermondsey and other districts. Interested in aeronautics, he wrote a book on "Aerial Navigation", which contained a number of remarkable forecasts. In his lectures on the chemistry of metals, delivered at the Royal Institution in 1851–52, he attempted a classification of his own devising. In 1852 he visited Paraguay and drew up a scheme for the colonization of the Gran Chaco. He pointed out the wastage of beef and other animal matter, which could be used for making ammonia or saltpetre, and suggested that the vast stores of timber wasted might be turned into huge unsinkable rafts across the Atlantic. Mansfield's chief contribution to theoretical chemistry was his "Theory of Salts", published in 1855. He was engaged in preparing samples of benzene for the Paris Exhibition, when on February 17, 1855, a naphtha-still in his laboratory at St. John's Wood overflowed. Severely burned, he died nine days later at the Middlesex Hospital, at the early age of thirty-six.

Catalogue of Optical Instruments

NEW illustrated editions have recently been issued of Sections *D* and *M* of the "Hilger General Catalogue" (obtainable from the Hilger Division, Hilger and Watts, Ltd, 98 St Pancras Way, London, N.W 1) Section *D* deals with monochromators for ultra-violet, infra-red and visible radiation and with wave-length spectrometers and specialized spectroscopes, and mention is made of a new series of monochromators, now in the final stages of design, which are planned to replace the former Muller–Hilger Uvisor instruments. Section *M* deals with a wide range of apparatus, including refractometers, polarimeters, temperature regulators, strain viewers, and photoelastic and electrophoresis apparatus Two types of temperature-regulating devices for optical instruments fitted with water jackets are offered For precise measurements the B.T L thermostatic water circulator made by Baird and Tatlock (London), Ltd, and designed in conjunction with the Hilger Division of Hilger and Watts, Ltd., is recommended, and for less critical work the Gallenkamp water heater, which is well suited for the Abbe type of refractometer Other refractometers described are the Hilger–Chance refractometer for solids and liquids, the Rayleigh interference refractometer for gases or for liquids, and a thin-film ultra-violet refractometer for liquids

National Institute of Agricultural Botany

The work of the National Institute of Agricultural Botany during the past year is reviewed in its *Journal* (7, No. 1, 1954) This number includes an account of the oldest regional trials centre, the Norfolk Agricultural Station, and in various ways indicates the many sides of the Institute's work, including reports of trials, classifications of varieties, methods of assessing premature germination (that is, 'sprouting') in wheat, and a further report from St. Albans on quality of oats This latter paper describes an interesting investigation into decayed kernels. There is also a full report on the crop conference held in December 1953 The proceedings were of general interest, and the emphasis on quality is of topical importance It was probably the first occasion when growers' representatives of so many areas have been able to meet millers and bakers, maltsters and brewers, for a full discussion of their different points of view

Fifteenth International Congress of Zoology, London, 1958

The Fifteenth International Congress of Zoology is to be held during July 16–23, 1958, and will meet in the Imperial College of Science and Technology, London The president is Sir Gavin de Beer, director of the British Museum (Natural History), secretary-general, Prof H R Hewer (Imperial College, London, S.W 7), assistant secretary-general, Dr. G. E Newell (Queen Mary College, London, E 1) In preparation for the work on zoological nomenclature by the Congress, arrangements will be made by the International Trust for Zoological Nomenclature in conjunction with the secretariat of the Congress for a colloquium on zoological nomenclature to be held immediately before the Congress, to start on July 7. The task of the colloquium will be to examine in detail the draft text of the *Règles* as amended by the Paris and Copenhagen Congresses, prior to their submission to the Congress for adoption Formal invitations to attend the Congress will be issued in September 1957 All communications meanwhile should be sent to the Secretary-General at the above address

Royal Astronomical Society Officers for 1955–56

The following have been elected officers for 1955–56 of the Royal Astronomical Society *President*, Sir Harold Jeffreys, *Vice-Presidents*, Dr J Jackson, Prof. A C B Lovell, Dr R A. Lyttleton (*geophysical secretary*), and Prof H H Plaskett, *Treasurer*, Prof L M Milne-Thomson, *Secretaries*, Prof C W Allen and Dr A Hunter, *Foreign Secretary*, Sir Harold Spencer Jones, *Council*, Dr A Armitage, Dr D E Blackwell, Prof. H. Bondi, Mrs E. M Burbidge, Mr E H Collinson, Prof. V C A. Ferraro, Mr T Gold, Dr R W. B Pearse, Dr J G Porter, Dr S. K Runcorn, Mr. D H Sadler and Dr P A Sweet

Announcements

H R H. The Duke of Edinburgh has been elected the first Honorary Fellow of the Pharmaceutical Society of Great Britain

President's Awards announced on Indian Republic Day (January 26) have been made to Prof V. R Khanolkar, director, Indian Cancer Research Institute, Bombay, India, and to Prof M. S. Thacker, director, Indian Institute of Science, Bangalore, India

Mr W S Bisat, a well-known civil engineer of Leeds and Fellow of the Royal Society, has been awarded the Liverpool Geological Society Medal in recognition of his work on goniatite faunas and their use in the subdivision of the Carboniferous in the North of England

Mr R H Gummer, a director of International Combustion, Ltd, and associated companies, has been elected president of the Institute of Fuel, in succession to Dr W Idris Jones, director-general of research to the National Coal Board. Mr Gummer is a founder-member of the Institute, and is well known for engineering activities connected with fuel

Dr. C J. Gadd, keeper of Egyptian and Assyrian antiquities at the British Museum, has been appointed to the University of London chair of ancient Semitic languages and civilizations tenable at the School of Oriental and African Studies The title of reader in agronomy in the University of London has been conferred on Mr A G Davis in respect of the post held by him at Wye College

The fourteenth International Horticultural Congress will be held at Scheveningen, Holland, during August 29–September 6 Further information can be obtained from the Honorary Secretary, International Horticultural Congress, Ministry of Agriculture Bezuidenhout 30, The Hague.

The first International Congress on Documentation of Applied Chemistry will be held in London during November 23–25 Further information can be obtained from the Honorary Secretary, International Congress on Documentation of Applied Chemistry 56 Victoria Street, London, S W.1.

A conference on "Low Temperature Physics" will be held under the joint auspices of the International Union of Pure and Applied Physics and Commission I of the Institut International du Froid as part of the four-yearly International Congress of Refrigeration which commences at the Sorbonne Paris, on August 31 The first sessions will be mainly devoted to the applied aspects of low-temperature physics, those concerned mainly with pure physics will begin on September 2 The proceedings will end on September 8 Further information can be obtained from Prof L Weil, Institut Fourier, Place du Doyen Gosse, Grenoble, Isère.

EARLY SCHOOL LEAVING

AN inquiry into the factors influencing the age at which children leave school, and the steps desirable to increase the number of those who stay after the age of fifteen, has been completed by the Central Advisory Council for Education (England). The Council's findings and recommendations have been published in a report, "Early Leaving" (H.M.S.O., 1954. 3s. 6d. net) (see also p. 313).

A comprehensive study was made of the number of leavers at various ages, something of their background, school records, motives and subsequent careers. For this purpose, a 10 per cent sample was taken of maintained and direct-grant grammar schools in England.

The heads of 114 schools completed a questionnaire giving as much information as possible on these lines in respect of each boy and girl who entered school with the intake of September 1946. In addition, evidence was secured from boys and girls themselves, through youth clubs and certain groups of national servicemen.

One of the most important factors influencing the age at which boys and girls leave school was found to be the home background. Professional and managerial families' children accounted for only 15 per cent of the child population, but represented 25 per cent of the grammar school population and 43.7 per cent of the sixth-form complement.

School records of children in different social groups were studied, and it was found that from children of parents in professional or managerial occupations at one extreme to the children of unskilled workers at the other there is a steady and marked decline in performance at the grammar school, in the length of school life, and in academic promise at the time of leaving. This is not a mere development of the better performance at the age of eleven of children in certain groups; it reflects a widespread changing of places in academic order between eleven and sixteen or eighteen years of age.

Shortage of money in itself is a less-common reason for leaving than some others—overcrowding in the home and "different social assumptions" are important considerations. The handicap of adverse home conditions, moreover, tends to increase throughout the school course and falsify many of the predictions made in the process of selection.

To meet the problem raised by unsuitable home conditions, the report recommends investigation and possible help by an appropriate social agency such as the school health service, provision of boarding facilities by local education authorities, and concessions by schools and education authorities, such as keeping the public libraries open until 9 p.m., keeping schools open after normal hours, in country areas the opening of primary school premises in the evening, and more generous assistance to youth clubs which cater especially for grammar school pupils.

Boys tend to stay longer at school than girls and do rather better academically. Evidence confirms the common belief that many parents attach more importance to their sons' education than to that of their daughters.

The Council found that while there has been a continued and marked tendency towards a longer school life since the War, there was a very large number of boys and girls leaving at fifteen who would do well to stay on at school for another year. The value of a school life extending beyond sixteen depends on the character, and especially the intellectual ability, of the particular child.

From the grammar school intake of 1946, in addition to about 10,000 boys and 7,000 girls who took advanced sixth-form courses, there were about 5,000 boys and 5,000 girls who had the capacity to do so if they had stayed longer at school. Of these, about 2,900 boys and 1,300 girls would have been suitable for courses in science or mathematics. There is a great national need for scientists of many kinds; all the scientists of good quality that the schools can produce will be absorbed if the universities and technical colleges can expand their scientific intake. The problem remains of providing the necessary scientific staff for the schools; but if this can be solved, the 4,200 potential scientists out of the additional 10,000 boys and girls who could well take advanced courses should have no difficulty in finding suitable occupations. It is acknowledged that "some of those who have the intellectual capacity for sixth form work may be right to leave without undertaking it"; but if pupils capable of taking advanced courses can be persuaded to stay at school they will be serving both the community and themselves.

The Council recommends that, in drawing up building programmes, local education authorities should estimate generously the need for grammar school places to allow both for an expansion in the size of their intake and also for an increased proportion in the fifth and sixth forms.

The process of selection for secondary education should allow for a small number of grammar school places to be filled at each individual school by alternative methods; more transfers from modern to grammar schools, even after the age of fifteen, should be made.

Local education authorities should review the circumstances in which children leave school early for financial reasons, and adjust their schemes of aid accordingly.

Drastic revision of the less-generous scales, provision of higher grants for older children, generous allowances in respect of further dependent children, and consideration of the use of scales based on net rather than gross income, are the main suggested needs. The Council also believes that the law should be amended to provide for the payment of family allowances for children still at school up to any age. At present such allowances cease when the child reaches the age of sixteen.

A number of recommendations are made for the consideration of employers, trade unions and professional bodies. Many young people, especially boys, leave school early in order to get a job. Conditions of entry to many professions and trades do not encourage a longer school life; craft apprenticeship schemes influence boys to leave school at not later than sixteen. The possibility of reducing the length of craft apprenticeship for boys who have stayed at school for a full five-year course should be considered, and the number of student apprenticeships increased, terms of admission to the professions should provide a greater incentive to pupils to reach sixth form standard In clerical and office careers, there should be a more effective system of grading linked with minimum ages of entry and differential scales of pay

The report also makes suggestions for administrative action within the schools These include treating the whole work of the school, including the sixth form, as continuous, and introducing some transition to sixth-form ways of working earlier in the school course, providing more science facilities for girls and experimenting more widely in such courses for boys, providing comparable courses for pupils of similar ability in grammar and modern schools, maintaining regular personal contact with the home and increased co-operation with the Youth Employment Service and employers

T H HAWKINS

CENTENARY OF ALUMINIUM

DURING June 1–11, at the Royal Festival Hall, London, the aluminium industry is presenting a Progress Exhibition, not only to mark the centenary of aluminium as a commercial metal but also to demonstrate how the present vast output and unique experience already gained are now being applied to every great industry in increasing measure It was at the Paris Exposition in 1855 that the French scientist, Prof St Claire Deville, who had succeeded in extracting aluminium from clay by a chemical process, exhibited samples of the metal Aluminium was rated a precious metal, since it cost £60 per pound to produce The first article to be made of the new metal was a rattle for the child of the Emperor Napoleon III, who ordered aluminium cutlery to replace the gold plate at the Tuileries banquets An aluminium watch-chain was also presented to the King of Siam, when on a State visit to France Attracted by its light weight, the Emperor commissioned Deville to produce aluminium on a large scale so that, with its cost reduced, it could be used for equipment for his soldiers However, only ten tons of aluminium were produced in the whole world in the next ten years, its lowest price being £3 per lb

In 1886, Charles Martin Hall in the United States and Paul Heroult in France, working independently, simultaneously patented the electrolytic process for extracting aluminium from its oxide To-day, using basically that same method of extraction, 30,000 tons of pure aluminium are produced in Britain alone, at the great hydro-electric plant in the Scottish Highlands, and world production in 1954 has probably exceeded three million tons and is still increasing From £144,400 per ton its price is now £165 per ton, and aluminium has the distinction of having increased in price to a less extent than any other important commodity In 1907 came the discovery by a German scientist, Alfred Wilm, that by alloying small quantities of other metals with aluminium, its strength could be greatly increased Further research and development in Britain produced a wide range of alloys which made possible the development of the aircraft industry and of the internal combustion engine

The ten years that have followed the Second World War have been years of remarkable progress when research results have been applied to problems in every industry First came the aluminium prefabricated house, 70,000 of which were built, to be followed by the adoption of aluminium in permanent building construction In shipbuilding its success was never more strikingly demonstrated than by the great American liner *United States*, which has more than two thousand tons of aluminium in her superstructure, lifeboats and many fitments, less spectacular applications of aluminium to ships had already become a commonplace in Britain The world's first aluminium bridges have been built in Britain, and aluminium coaches of London's Underground trains, and aluminium bus bodies on London's streets, provide ample evidence of the faith of the engineer in aluminium.

Its light weight and its resistance to corrosion, symbolized by Gilbert's famous aluminium statue of 'Eros'—now more than sixty years old—have made this the 'Light Metal Age' If the progress, especially in the past ten years, has been remarkable it is still only a beginning, for the future of aluminium is boundless in its possibilities

THE VICUNA

IN a recent issue of *Oryx*, Dr G Dennler de la Tour has described the characteristics, habitat and behaviour of the vicuna (11, No 6, December 1954)

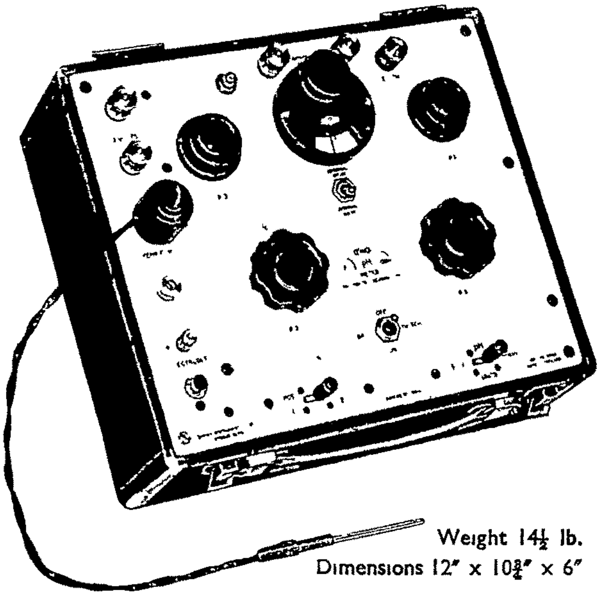
In form the vicuna resembles the guanaco, but it is smaller and slenderer Its colour varies from pale fawn, through vermilion and golden to strongly fulvous. The vicuna has no black on its face, as has the guanaco From the throat to the knees there is a pure white tuft, the belly and inner sides of the limbs being white also The vicuna stands 28–35 in high at the shoulder, its average size decreasing from south to north in its South American range Its wool is shorter but much finer than that of the guanaco and is probably the finest and lightest wool in the world. Vicunas are found in small droves of five to fifteen females led by an adult male which watches over the flock Young males are expelled from the flock by their mothers when they are eight to ten months old and unite into herds of from twenty to a hundred or more

The mating season lies between April and June and, as the gestation period is ten months, parturition occurs between January and March The vicuna almost always produces one offspring, in confinement it does not breed readily

Vicunas feed on grasses of *Poa*, *Bromus*, *Agrostis* *Stipa*, and other alpine genera They drink only every two days and always use the same track to water

The vicuna, generally speaking, lives at higher altitudes than the guanaco It enjoys humid meadows which lie adjacent to the eternal-snow summits of the Andes, many of which reach and pass the 6,000 metre mark

Vicunas occur in the high plateaux of the Andes between 3° S and 30° S, that is, in the extreme south of Ecuador, in Peru and Bolivia, in the extreme north of Chile and in north-western Argentina Their southern limit is in Argentina at about the Agua Negra River, while their Chilean range does not go so far southwards Where man has advanced with his sheep and goats, alpaca and lama breeding



DORAN

UNIVERSAL pH METER

CAT No M4982

This precision instrument embodies almost every possible feature considered desirable in a modern pH Meter. In addition to high accuracy it provides utmost simplicity in adjustment and reading together with reliable automatic temperature compensation. The electrometer valve employed has remarkable stability, negligible grid current and very low current consumption.

Specification·

Ranges
0-14 pH units and 1,400-0-1,400 millivolts.
Accuracy
1 millivolt and 0.01 pH unit.
Batteries
External 2 (or 1.5) volt; internal 15 volts
Consumption
External 50 mA; Internal 0.5 mA.
Supplied in teak or laminated bakelite case.

Weight 14¼ lb.
Dimensions 12" x 10¾" x 6"

Further details are given in our List 109A

DORAN INSTRUMENT CO. LTD.
STROUD, GLOS.

Tel STROUD 462

London Office:
Tel · ADD 2369

Variational Principles in Dynamics and Quantum Theory

• •

By WOLFGANG YOURGRAU, Dr Phil.
and STANLEY MANDELSTAM,
B Sc (Eng), B.Sc (Rand)

In this book, the authors deal with the mathematical foundations of Variational Principles and those sections of dynamics (such as the Hamilton-Jacobi theory) to which they are related. The principle of least action is analysed also from a historical viewpoint, while an evaluation is attempted of the conflicting philosophical conclusions which eminent scientists have reached on this subject. Allied topics discussed include an examination of the role of Variational Principles in the development of quantum mechanics, as well as the application of Hamiltonian methods to electrodynamics. 25/- net

PITMAN

Parker Street, Kingsway, London, W.C 2

The latest

ANNUAL REVIEWS

	Volume
Medicine	5
Psychology	6
Physiology	16
Microbiology	8
Biochemistry	23
Nuclear Science	4
Plant Physiology	5
Physical Chemistry	5

Back volumes also available

$7.00 POSTPAID (U.S.A.); $7.50 POSTPAID (ELSEWHERE)

ANNUAL REVIEWS, INC.

STANFORD, CALIFORNIA, U.S.A., H. K. LEWIS & CO., LTD., 136 GOWER STREET, LONDON, W.C.1, ENGLAND, MARUZEN CO., LTD., 6 TORI-NICHOME NIHONBASHI, TOKYO, JAPAN

ANALYSIS OF DEVELOPMENT

BENJAMIN H WILLIER
(Professor of Zoology, Johns Hopkins)

PAUL A WEISS
(Member Rockefeller Institute for Medical Research)

VIKTOR HAMBURGER
(Professor of Zoology, Washington University)

735 pages 248 figures 105s.

A work of great distinction which presents a summary of the present state of knowledge, and problems under investigation, of the stages in the embryological development of animal organisms. Each chapter is written by a specialist with the editorial supervision of three eminent embryologists

CONTENTS

1. Problems, Concepts and Their History
2. Methods and Techniques
3. Cellular Structure and Activity.
4. Nucleus & Cytoplasm in Development.
5. Embryogenesis Preparatory Phases
6. Embryogenesis : Progressive Differentiation
7. Special Vertebrate Organogenesis
8. Energy Exchange & Enzyme Development.
9. Ontogeny of Immunological Properties.
10. Ontogeny of Endocrine Correlation
11. Determination of Size
12. Metamorphosis
13. Regeneration
14. Teratogenesis.

A work of great importance and of outstanding authority It is of great special interest to embryologists and of considerable general interest to all biologists of whatever category

W. B. SAUNDERS COMPANY LTD.
7 Grape Street, London, W C 2

Just Published—Volume VI

Advances in Electronics and Electron Physics

Edited by L MARTON

Dec 1954, 538 *pp*, *illus*, 94*s* 6*d*.

Starting with Volume VI, this series will be entitled *Advances in Electronics and Electron Physics* (rather than *Advances in Electronics*) in order to reflect more adequately the contents of the volumes The modified title acknowledges that the word *electronics* now generally refers to circuitry and components whereas the series has a far broader coverage

CONTENTS:

Metallic Conduction at High Frequencies and Low Temperatures
By A B Pippard

Relaxation Processes in Ferromagnetism
By Elihu Abrahams

Physical Properties of Ferrites
By J Smit and H P J Wijn

Space Charge Limited Currents
By Henry F Ivey

A Comparison of Analogous Semiconductor and Gaseous Electronics Devices
By W M Webster

The Electron Microscope—A Review
By M E Haine

Traveling-Wave Tubes
By Rudolf G E Hutter

Paramagnetism
By J Van den Handel

Author Index—Subject Index

Academic Press Inc.
New York 10, N.Y., U.S.A.

British Office: **ACADEMIC BOOKS LTD.,**
129 Queensway, London, W.2

MACMILLAN BOOKS

Advanced Level Examples in Physics

R V. JOHNS, M A , B Sc

Lecturer in Physics and Mathematics, City of Liverpool College of Technology

W. F. WARE, B Sc , A.Inst P

Senior Physics Master, Cathays High School for Boys, Cardiff

This book of numerical examples is designed to supplement the theoretical and laboratory work of students preparing for examinations in Physics at the Advanced level of the General Certificate of Education and for Intermediate Degree examinations Some 1,000 examples have been arranged by topics and carefully graded in difficulty. Contents are arranged under the headings Mechanics and Properties of Matter, Heat, Light, Sound, and Magnetism and Electricity 16*s*

A Text-book of Electricity and Magnetism

G R. NOAKES, M A , F Inst.P.

This is the new, Third Edition of a book which will meet the need of those taking Intermediate degree courses and the Advanced and Scholarship Examinations of the General Certificate of Education All the usual topics required at this stage are dealt with, and where necessary calculus is used Among the special topics discussed are the conduction of electricity through gases, atomic physics and modern views on ferro- and terrestrial magnetism *Third Edition* 14*s*

Semimicro Qualitative Analysis

A Course in Applied Chemical Equilibrium

EDWIN O. WIIG, Ph D , WILLARD R LINE, Ph.D , and JOHN F FLAGG, Ph D

This revision of *Semimicro Qualitative Analysis*, while retaining the experimental procedures and much of the form of the earlier text, has been almost completely rewritten The theoretical section has been considerably expanded and a large number of problems of varying difficulty (with the answers to many of them) have been added The sections on special procedures for ferro- and high-aluminium alloys have been modified on the basis of student experience. 25*s.*

Science and its Background

H D. ANTHONY, M A.(Cantab), B Sc , Ph D (Lond), F R A.S

Here is the story of science, with the background of history in which that story is set Although most of the chapters centre around individual men of science whose work is of value to day, the historical background is not only that of isolated biography but the continuous history of human affairs Two chapters, on post-war developments and the pursuit of science for its own sake, have been added for this second edition. *Second Edition* 20*s*

All prices are net

St. Martin's Street, London, W.C2

Announcing the publication of

Journal of Inorganic and Nuclear Chemistry

Editorial Advisory Board
J. S ANDERSON
A H. W ATEN, JR
J. C. BAILAR
J. BJERRUM
F. M. BREWER
E. O. BRIMM
H. C. BROWN
A. B. BURG
G. E COATES
C. D. CORYELL
J H DE BOER
R W. DODSON
H. J. EMELÉUS
F FAIRBROTHER
W C FERNELIUS
J. GUÉRON
G HÄGG
H. HARALDSEN
ODD HASSEL
W. HIEBER
H M N. H IRVING
G. JANDER
W. C JOHNSON
B. KARLIK
J KLEINBERG
W. F. LIBBY
A G. MADDOCK
M. MAGAT
W. J MANNING
T. MOELLER
A MUENSTER
A. R POWELL
P L. ROBINSON
E. G. ROCHOW
H I SCHLESINGER
W C SCHUMB
G SCHWARZENBACH
G T. SEABORG
P W SELWOOD
L G SILLEN
F H SPEDDING
R SPENCE
J. W. T. SPINKS
H. G. THODE
A E VAN ARKEL
E. J W. VERWEY
H L YAFFE
W H. ZACHARIASEN

Editors
JOSEPH J. KATZ, *Argonne National Laboratory*
H C LONGUET-HIGGINS, *Cambridge*
H. A. C. MCKA, *A.E.R.E., Harwell*

Inorganic chemistry is to-day a lively and developing subject. There ar advances in many fields, but perhaps the greatest stimulus has com from nuclear science, with its need for knowledge of thorium, uraniu and the transuranium elements, of the fission products, of poor neutro absorbers and indeed of every element in the periodic table.

The Journal will publish original research papers, both experimenta and theoretical The boundary between this and other branches o chemistry may not always be easy to define, but the emphasis will b primarily on inorganic chemistry.

Contents of the first number (March 1955):

- RICHARD A GLASS, STANLEY G. THOMPSON and GLENN T. SEABORG: Nuclea thermodynamics of the heaviest elements
- D. J M. BEVAN: Ordered intermediate phases in the system CeO_2—Ce_2O_3.
- R. W M D'EYE and P. G. SELLMAN· The thermal decomposition of thorium oxalat
- EUGENE G ROCHOW and HUGH G. LECLAIR: On the molecular structure o methyl silicone.
- CHARLES D CORYELL and RICHARD C. FIX· The Hammett acidity function H_0 i H_2SO_4-SO_3 mixtures.
- G. JANDER and H KLAUS: Über elektrometrische Titrationen in wasserfrei Essigsaure
- W. F. LIBBY and HARO V. BUTTLAR: Natural distribution of cosmic ray produce tritium II
- F. G. A STONE and DIETMAR SEYFERTH. The chemistry of silicon involvin probable use of *d*-type orbitals
- H. C LONGUET-HIGGINS and D A. BROWN. The dynamics of binary hydride
- L. E. GLENDENIN and E P STEINBERG. Fission yields in spontaneous fission of Cf^{25}
- J SUTTON: Hydrolyse de l'ion uranyle et formation d'uranates de sodium.
- G N WALTON and I. F. CROALL Chemical effects in fission product recoil.
- F. ROSSOTTI· The homogeneous exchange reaction between monovalent an trivalent thallium
- J. G CUNINGHAME, J. EAKINS, E. R. MERCER, M. L SIZELAND and H. H WILL The rapid separation of rare earth fission products by cation exchange, usi lactic acid eluant.

There are two subscription rates, A and B, details of which are as follows:

Subscription A—the normal subscription rate of £4 10s ($12 60) per volun including postage, for libraries, research departments, firms, Government offi and similar organisations,

Subscription B—a special concessionary rate of £3 10s ($9.80) per volume includi postage, for private individuals only, who will be asked to complete a certific to the effect that the journal is for their personal use.

PERGAMON PRESS LIMITED
242 Marylebone Road, London, N.W.1

● ●

NTRODUCTION TO

Process Control System Design

. *J. YOUNG, B A , B Sc*

This is a straightforward explanation of the fundamentals of the subject, and the student or beginner is given a real understanding of the principles governing the operation of control systems. The author examines the basic principles in quantitative terms with emphasis on dynamic characteristics, and he uses plain English and only the simplest mathematics.

This is an important book for everybody concerned with plant design For the instrument technologist, for the chemical engineer; for physicists, engineers and chemists; and it is written by a leading expert in the field. Mr. Young is Head of the Central Instrument Laboratory of Imperial Chemical Industries. Illustrated, **42s.** net, April

An Introduction to Botany. *THIRD EDITION*

. H. PRIESTLEY, D S O , B Sc , F L S , and LORNA I. SCOTT, M Sc , F L S

This book, designed for first-year students, has been revised throughout and in many places, particularly the physiological sections, has been re-written. The course concentrates on the flowering plant, and life-cycle work is introduced mainly in its relation to the life-history of the angiosperm. In an endeavour to improve the teaching of plant anatomy, the authors have introduced, wherever possible, alternative techniques to enable the student to build up a three-dimensional picture of the reconstruction of the tissues in a way that is not possible by the use of sections alone. Illustrated, **30s.** net, July

Structural Analysis. *SECOND EDITION*

W. FISHER CASSIE, Ph D , M Inst C.E., F.R S E

Although most students can comprehend and appreciate the fundamental conceptions on which the Theory of Structures is based, many find difficulty in applying these principles to numerical problems. This book demonstrates how such application can best be made Each chapter shows, by a series of graded examples, how one particular method of analysis is employed The text is intended as a working guide, and each problem should not merely be read, but should be calculated afresh by the student. A few of the problems indicate the modifications required in practice, illustrating the shortened methods and approximate treatments which may be used in the analysis of complex frames. The book does not, however, consider the design of structures, and is intended for the student of theory The work is confined to statically indeterminate structures, and it is assumed that the reader has studied the theory of simple beams and frames, and is familiar with elementary integration.

Illustrated, **18s.** net

ONGMANS

-7 Clifford Street, London, W.1 ●

LARGE-SIZE
POROUS
FILTER TUBES
for dust recovery

In the recovery from gases of catalytic fines, of dust or of similar materials, Royal Doulton porous ceramic filters give outstanding performance.

Advantages include —

- Uniformity of pore size, pore distribution and permeability
- Good mechanical strength
- Suitability for operation over a wide range of temperatures
- Resistance to corrosion
- Ease of cleaning—with air, steam, water or chemicals

Royal Doulton porous ceramic filter tubes in various grades from 50 to 750 microns measured maximum pore size can be made in lengths up to 5 feet

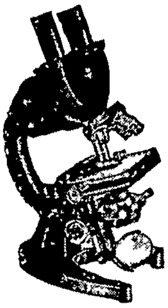
Write for Catalogue No 10
DOULTON & CO. LIMITED,
Industrial Ceramics Division, Dept. C,
Doulton House, Albert Embankment,
London, S.E.1.

Royal
DOULTON
FILTERS

F12R

MICROSCOPES . Guarantee

BY THE LEADING SPECIALIST

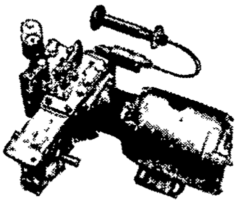


Watson "Kima", 2 objectives, £24 10s , Zeis
3 eyepieces, 3 objectives, £33 10s , Beck Medica
3 objectives, £32 10s , Watson "Service", Medica
£32 10s , Beck Medical, 2 objectives, £22 10s
Bausch & Lomb, Botanical, £7 10s , Beck 47C (2a
£45 10s , Watson "Service", Laboratory, £47 10s
C T & S , Medical, 2 objectives, £22 10s

By appointment to
[illegible]

WALLACE HEATON L
127 NEW BOND STREE
LONDON, W 1 Tel MAYFAIR 751

INFINITELY VARIABLE SPEED



Unit illustrated ¾ H P Brook Gryphon Motor, 5 1 Croft Worm Reduction Gear, both flange-mounted to the Transmission, which is fitted with hydraulic (remote) control (Output speed 0-174 r p m max torque 450 lb in)

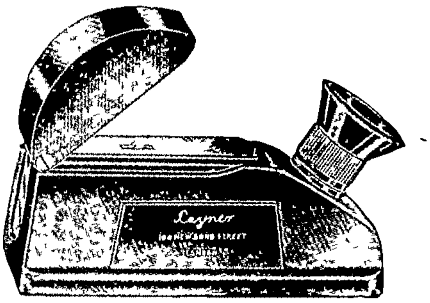
Hydraulic Gears at less than 15% of original cost

Write for full details

Illustrated brochure and long list
famous users sent by return Originall
made by Vickers-Detroit at over £23
Each unit transmits up to 2 B H P Ze
to 1,240 r p m in either direction S
months' guarantee Units now als
supplied complete with electric motor
starters, remote controls, reduction gear
etc , if required.

N. J. TATHAM & CO. LT
(Dept 6) . Lowfield Works · Haywards Heath · Susse

RAYNER
REFRACTOMETER



Price. In case with 1.81 fluid, yellow filter and polarizing filter, £15 16s.

Scale 1 30–1 86 in intervals of 0 01 Estimation to 0 001 in white light with filter Designed for mineralogy, gemmology, routine checks for transparent solids, and for much work with fluids

RAYNER
100 NEW BOND STREET, LONDON, W 1
Telephone GRO 5081

The SCIENTIFIC BOOK SUPPLY SERVICE
(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

A large variety of marine animals and plants can be supplied either iving or preserved Orders should be placed well in advance for living naterial

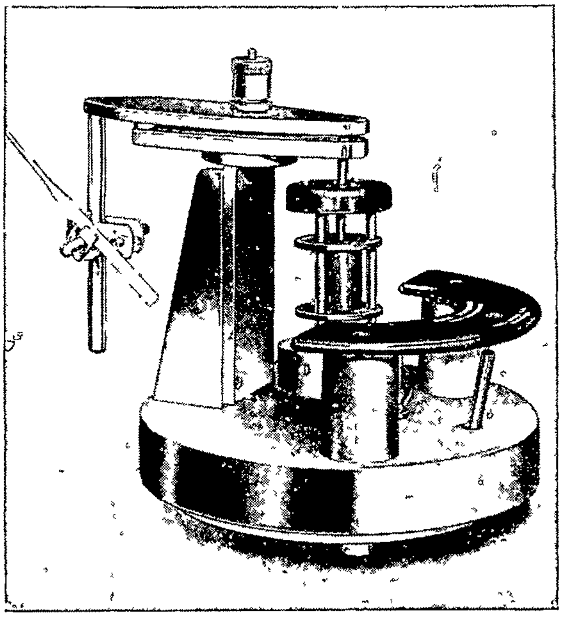
For price-list and other information apply to —
HE DIRECTOR, THE MARINE BIOLOGICAL LABORATORY PLYMOUTH

BRASS • COPPER • DURAL • ALUMINIUM • BRONZE •
ROD, BAR, SHEET, TUBE, STRIP, WIRE
3,000 STANDARD STOCK SIZES
No Quantity too small • List on application

H. ROLLET & CO., LTD.
6, CHESHAM PLACE, LONDON, S W 1 SLOane 3463
Also at LIVERPOOL, LEEDS, MANCHESTER, BIRMINGHAM

SINGER MICROMANIPULATORS
(patent application 11559/43 Foreign patents pending)

s described by Barer and Saunders-Singer, Q J M S , Vol. 89, pp 439-74, Dec 1948



SINGER INSTRUMENT COMPANY LIMITED
ountain Court, 83 London Street, Reading, Berks, England
Manufacturers also of the Singer Microdissectors

published by **McGRAW-HILL LONDON**

Obtainable shortly from your bookseller

Introduction to

NUCLEAR ENGINEERING

Richard Stephenson
Consulting Editor

This is the first book to bring together the many unique engineering problems encountered in the nuclear engineering field Its main purpose is to afford engineers, who are taking, or have completed, a standard engineering curriculum, with the engineering problems encountered in the engineering field It includes details concerning reactor theory, radiation shielding, reactor materials, reactor control, separation of stable isotopes, chemical processing of radioactive materials, remote handling equipment and special engineering problems. Numerous examples and problems are illustrated throughout and references to declassified reports show where more detailed information can be found

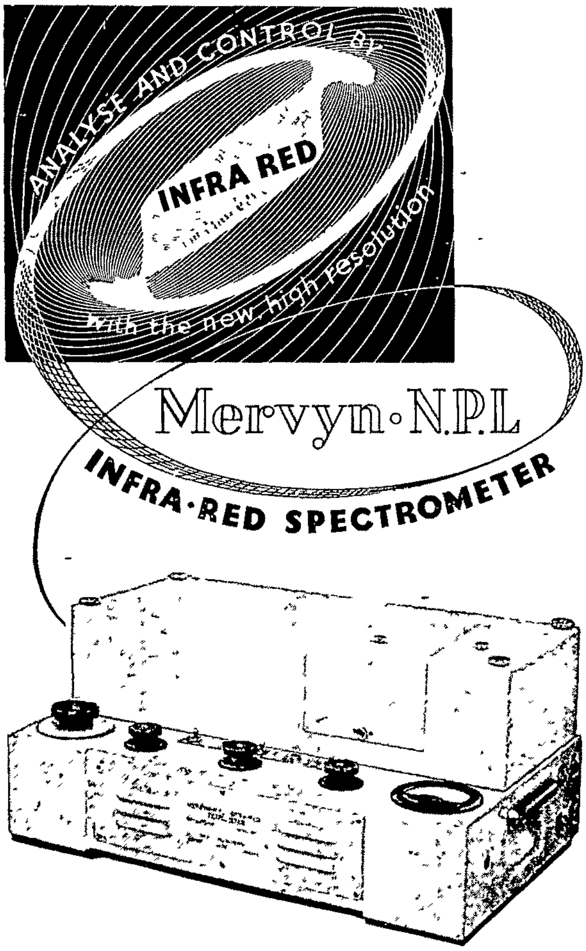
9 × 6 inches 500 pages 57*s* 6*d*

NUCLEAR PHYSICS

Alex E S Green
Associate Professor of Physics,
Florida University

The organisation and systematic treatment of this book have not previously been attempted at this level Until now such logical discussions of the foundations of nuclear physics have been confined to treatises addressed to specialists, research workers and advanced graduate students The subject is dealt with in a fashion appropriate to a vast field in an active state of change and development All major recent advances form part of the contents of NUCLEAR PHYSICS Topics such as the Wigner model, the collective model, the cloudy crystal ball model of nuclear scattering are discussed for the first time in a book of this kind

9 × 6 inches 475 pages 64*s* 6*d*



NOW—Infra-red analysis enters a new phase with the development of this Mervyn engineered instrument using Merton—N.P.L. diffraction gratings.

Here is the long awaited high resolution instrument for the 1 μ — 4 μ region. Of great stability, it reads percentage-transmissions direct.

USING A COMPLETELY NEW ELECTRONIC COMPENSATING SYSTEM

This versatile instrument is compact and simple to operate Has many applications in the manufacture of petroleum products, plastics, detergents, pharmaceuticals and other processes where the high cost of contemporary equipment has restricted the use of Infra-Red techniques

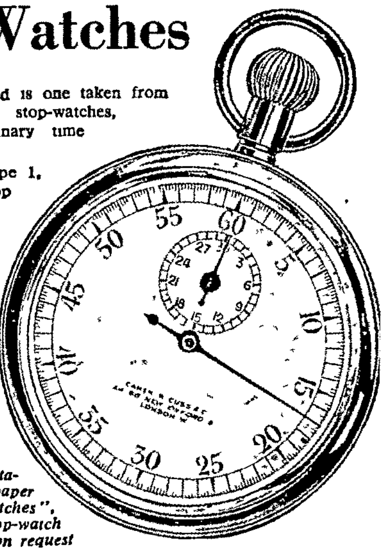
Send for full information to Dept IS 4

MERVYN INSTRUMENTS

ST. JOHN'S, WOKING, SURREY.
Telephone WOKING 2091

PB 01

Stop Watches



THE stop-watch illustrated is one taken from our new catalogue of stop-watches, chronographs and ordinary time of day watches

It is Model 01—a type 1, three-pressure action stop watch, recording up to 30 minutes One revolution of the large hand equals 60 seconds

In view of its relatively low cost and high accuracy the watch is very suitable for general laboratory use A 1/10th second watch model 03 is also available

A copy of our new catalogue, which includes a paper " Some notes on stop watches ", is of interest to all stop-watch users and will be sent on request

Guaranteed repairs Timing service Certification

Tachometers Time Interval Meters

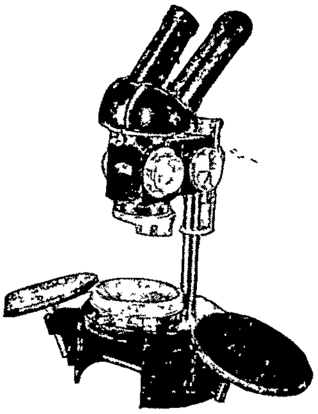
CAMERER CUSS

Timing Division

Makers of Good Clocks & Watches since 1788
AT
NEW OXFORD STREET, LONDON, W.C.1
MUSeum 8968/9
Our only other address 91 Kingsway, W C 2

CARL
ZEISS

STEREO MICROSCOPE



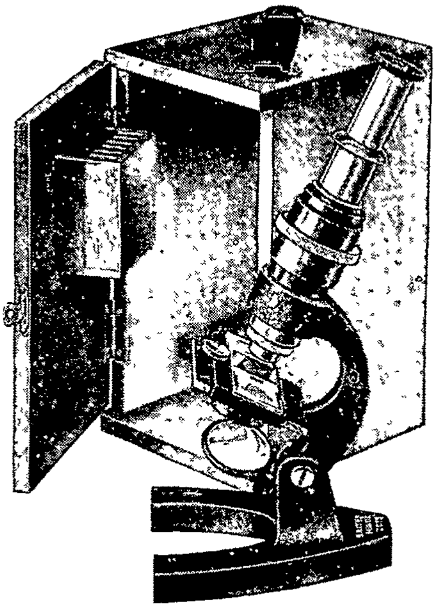
Rapid change of magnification in five steps from ×6 to ×40, ×12 to ×80, or ×24 to ×160 simply by turning a drum The long working distance remains unchanged with change in magnification
Illustrated booklet from

DEGENHARDT & CO., LTD.

32 MADDOX STREET, LONDON, W 1
Mayfair 6639
Sole importers for Gt Britain and N Ireland

BRITEX MINOR

MICROSCOPE



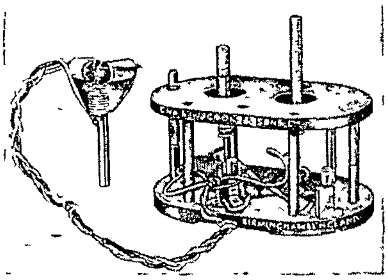
A scientifically constructed and compact miniature microscope, featuring adjustable magnification range of from 50 to 200 diameters and patent semi-mechanical stage Accessories iris diaphragm, condenser, and specially designed ⅛" and 1" objectives Supplied complete in mahogany box

Literature sent on request

BRITEX (SCIENTIFIC INSTRUMENTS) LTD.

Manufacturers of Microscopes, Magnifiers, Telescopes, etc
523-4, Bank Chambers, 329, High Holborn, London, W C I
Telephones HOLborn 0902 and 7166

HYDRAULIC MICROMANIPULATOR



A new Instrument with extremely fine sensitivity for the movement of bacteria under a microscope of high power

The Instrument is complete with coarse and fine liquid filled metal bellows controlled by rocking levers, which in turn actuate the bellows on head carrying the micro-tool

The apparatus is complete with clamp for fixing head to user's own microscope

The apparatus is supplied fitted into wood carrying case complete with all equipment as shown above

This Instrument, for which Patent Protection has been sought (Patent Application No 26976/52), is manufactured by Chas W Cook & Sons, Ltd, by permission of the National Research Development Corporation, who own the rights in this invention

It has been described by the Inventor, Mr K R May, in the Journal of the Royal Microscopical Society (part 3 of 1953—published December, 1953)

Further information and price from the makers

CHAS. W. COOK & SONS, LTD.

(Late Manchester and Ashby-de-la-Zouch) Established 1896
UNIVERSITY WORKS, 97, WALSALL ROAD,
PERRY BARR, BIRMINGHAM, 22B, ENGLAND
Telephone Birchfields 4223

"I spent a most interesting day yesterday, Sister! . . ."

" I saw 'PYREX' Precision Bore tubing being re-drawn in the 'PYREX' works "

" The ordinary tubing is carried over a steel mould (a mandril they call it) and is re-heated in the process It comes out the other side dead accurate to size and shape And that's the tubing they use for these hypodermic syringes I'm told it is accurate to four points of decimals "

" Yes, doctor, accuracy is certainly important, but what I find most remarkable is that these 'PYREX' syringes never crack or break even in the hottest water "

● **PYREX Precision Bore Glass Tubing gives exceptional resistance to thermal shock Normally supplied with a bore tolerance of ± 0 05 mm (±0 002 in), or for special requirements to bore tolerance of ±0 02 mm (±0 0008 in)**

● *Special leaflet giving details of lengths and bore sizes gladly sent on application*

'Pyrex' brand laboratory glassware is made only by James A Jobling & Co Ltd, Sunderland

Large new catalogue FREE
Send name, address and position in firm

MADE IN ENGLAND PYREX
REGD TRADE MARK

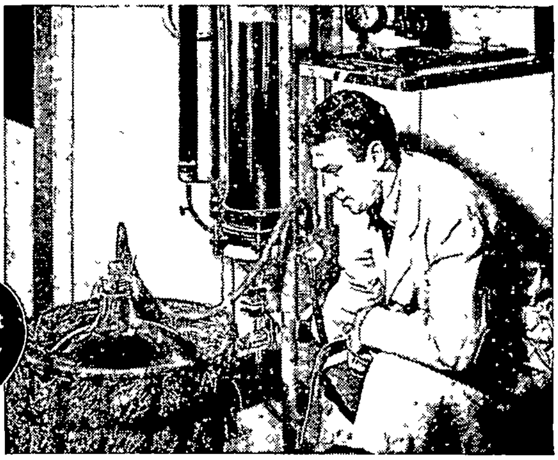
JAMES A JOBLING & CO LTD
Wear Glass Works Sunderland

THE ONLY MAKERS OF 'PYREX' BRAND GLASS IN THE UNITED KINGDOM

Incidental information

No. 8

items of interest from our laboratory notebooks



"**Stilbazo**" represents another flight of the chemist's fancy in the realms of abbreviated nomenclature It stands for *di*-Ammonium stilbene-4 4′-*bis*- (1-azo-3 4-dihydroxybenzene)-2 2′-disulphonate It can be identified also with equal brevity as H & W Code 9275 7 and is yet another reagent for aluminium

Catechol Violet, also known as Pyrocatechin Violet, adds to the versatility of Sequestric Acid (ethylenediamine tetra-acetic acid) It is used as an indicator when titrating bismuth and thorium with that protean reagent (V Suk, M Malat and O Ryba, **Chem Listy 48,** 203, 533, (1954) **C. A. 48,** 6309, 8114 (1954)) We were immediately in a position to meet such a demand—indicators have always been a speciality of Hopkin & Williams Ltd

H & W

HOPKIN & WILLIAMS LTD.

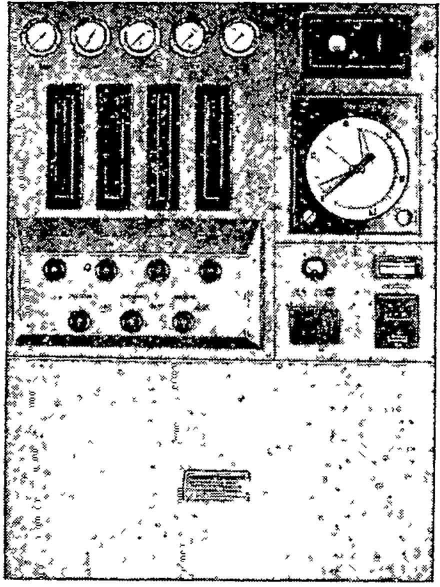
Manufacturers of Pure Chemicals for Research and Analysis

FRESHWATER ROAD CHADWELL HEATH ESSEX

BAKER PLATINUM INTRODUCE THE

Nitroneal Generator

for producing PURE NITROGEN with a controllable hydrogen content



The Nitroneal Generator produces pure nitrogen with a controllable hydrogen content by reacting ammonia with air in the presence of a special Baker catalyst The apparatus generates a gas completely free of oxygen, consisting only of nitrogen, hydrogen and water vapour The hydrogen content can be varied at will to meet changing requirements and can be maintained at any desired percentage between 0 25% and 25% within close tolerances This flexibility permits the use of the appropriate gas for any material or process at the lowest cost

IMPORTANT ADVANTAGES are ECONOMY HIGH PURITY SAFETY FULLY AUTOMATIC ADJUSTABLE GAS MIXTURE UNIFORM ANALYSIS QUICK STARTING NO MAINTENANCE

Write for leaflet giving full details Technical representatives available for consultation and advice

BAKER PLATINUM LTD. 52 HIGH HOLBORN, LONDON, W C 1. *CHAncery* 8711

Originators of the DEOXO Process for Catalytic Gas Purification and the DEOXO Indicator

here *(to quote only a few)*

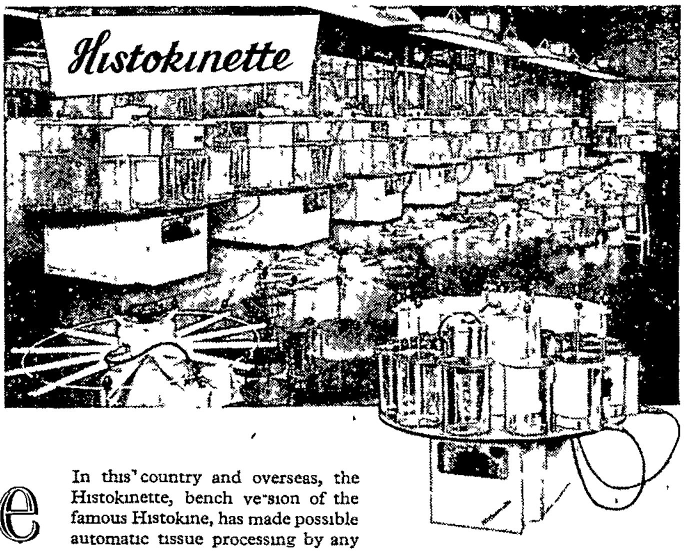
LONDON, DARLINGTON, GUILDFORD, NOTTINGHAM, SCARBOROUGH, SHEFFIELD, STOCKPORT, WOLVERHAMPTON, DUNDEE, EDINBURGH, SWANSEA

there *(Some of our Exports)*

ARGENTINA, AUSTRALIA, BRAZIL, CANADA, CUBA, DENMARK, EGYPT, FRANCE, HOLLAND, INDIA, NEW ZEALAND, SWEDEN, SWITZERLAND

and

everywhere



In this country and overseas, the Histokinette, bench version of the famous Histokine, has made possible automatic tissue processing by any histological technique. The complete routine of FIXATION—DEHYDRATION—WASHING or STAINING is taken out of the hands of the technician for 1 hour, 24 hours, or week-end periods

Write for illustrated brochures

HISTOKINETTE SPECIAL FEATURES INCLUDE

- ★ **Up to 24 hours delayed start**
- ★ **Double processing capacity**
- ★ **One or more motor members and baskets**
- ★ **Unbreakable tissue basket and container**

BRITISH INSTRUMENT INDUSTRIES EXHIBITION

EARLS COURT LONDON

June 28 - July 9 1955

STAND No. 5

Hendrey Relays

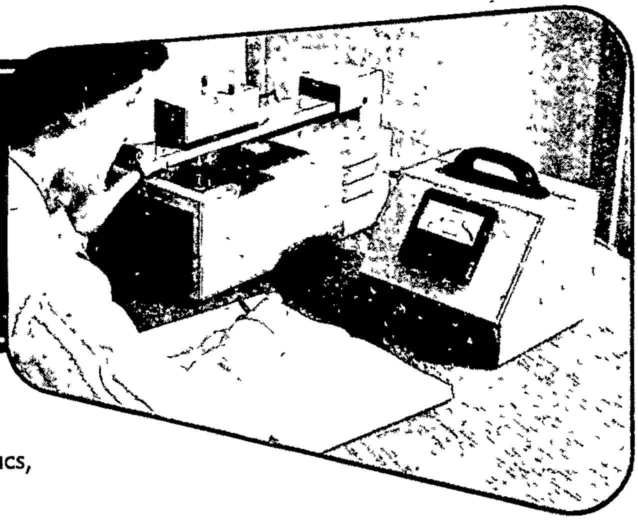
HENDREY RELAYS LTD., BATH RD., SLOUGH, BUCKS. (Tel Burnham 609/610)

MANUFACTURING ELECTRICAL ENGINEERS CONTROL & LABORATORY APPARATUS

HR

Transmission

DENSITOMETER

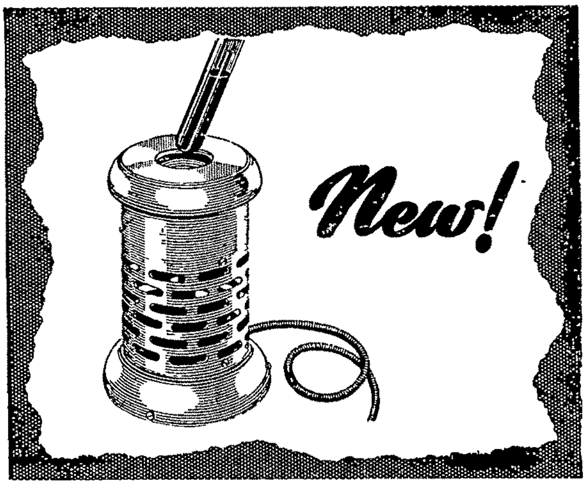


- Measures up to Density 6
- For colour comparison of fabrics, plastics, paper, etc
- Attachment for measuring turbidity of liquids, both static and moving
- Widely used for colour transparencies, black and white negatives and chromatograms

BALDWIN *scientific instruments*

LEAFLET No F/117

ALDWIN INSTRUMENT COMPANY LTD · DARTFORD KENT TEL 2948 (3 lines)



ELECTROTHERMAL "BUNSEN"
(Pat pdg. Regd Design 875,606)

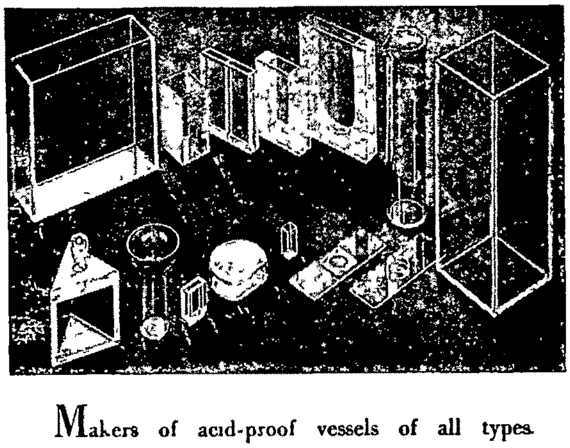
An indispensable apparatus for use in laboratories for heating test-tubes, crucibles, etc. Available from all Laboratory Supply houses. Write for leaflet now

Safe, efficient and economical in use. Guaranteed for 12 months.

Electrothermal Engineering Ltd.

170 NEVILLE ROAD, LONDON, E.7 Telephone GRAngewood 00

ACID-PROOF VESSELS



Makers of acid-proof vessels of all types. *Speciality* Cells for experimental purposes involving optical work of any accuracy.

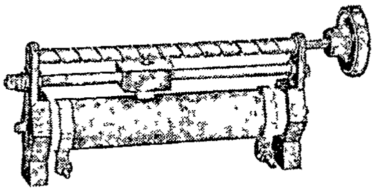
write for illustrated list

C. F. Whilems Ltd.

Ilford Optical Works, FOREST ROAD, BARKINGSIDE, ESSEX

Leslie Dixon & Co.
Established 1920

RESISTANCES–
Fixed or Variable with Geared Movement



Wire wound with best Nichrome wire on vitreous enamelled steel tubes Dimmer Resistances also available to your requirements

Prompt quotations to your specification.

Dept M, 214 Queenstown Road, Battersea, London, S W 8
Telephone MACaulay 2159

TRADE JAYGO MARK

Special & Standard Scientific Apparatus & Glassware

GLASS EQUIPMENT FOR FUME ABSORPTION

◆

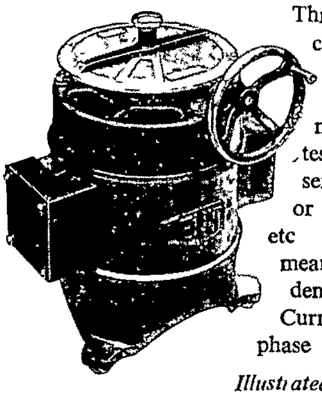
LABORATORY HOSPITALS AND PILOT PLANT EQUIPMENT FOR ANALYTICAL EDUCATIONAL AND RESEARCH PURPOSES

◆

THE JAGO COMPANY
90 RUSHOLME ROAD, MANCHESTER, 13

ZENITH
(REGD. TRADE-MARK)

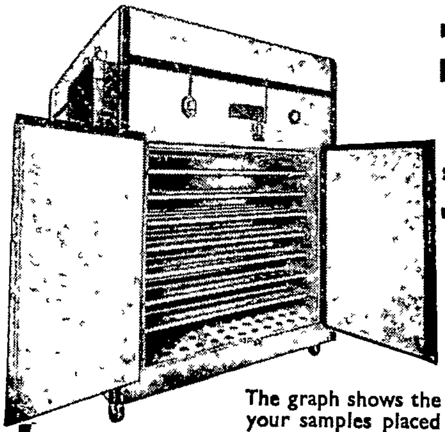
PHASE SHIFTING TRANSFORMER



This instrument provides convenient means for adjusting the phase angle or power factor in alternating current circuits when testing single or polyphase service meters, wattmeters, or power factor indicators, etc It is also the simplest means for teaching and demonstrating Alternating Current Theory as affecting phase angle and power factor.

Illustrated brochure free on request

The ZENITH ELECTRIC CO. Ltd.
ZENITH WORKS, VILLIERS RD., WILLESDEN GREEN
LONDON, N W 2
Phone WILlesden 6581–5 , *Grams* Voltaohm, Norphone, London
MANUFACTURERS OF ELECTRICAL ENGINEERING PRODUCTS INCLUDING RADIO AND TELEVISION COMPONENTS



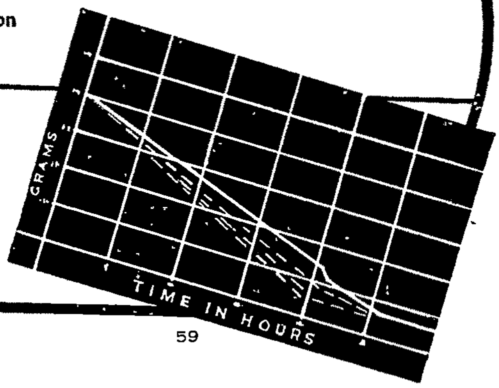
LABORATORY TESTED & APPROVED

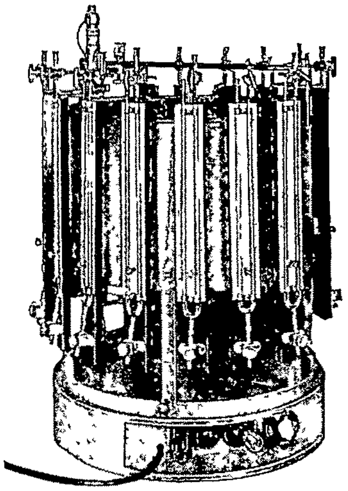
The UNITHERM DRIER has been carefully tested under working conditions, and is now being used in Laboratories and Grassland Research Stations all over the world, to provide rapid Uniform Drying at temperatures controlled within ± 2° C up to 110° from 40° C.

The graph shows the uniform rate of drying of your samples placed in different parts of the oven.

Full details will be gladly sent to you upon request

BIRMINGHAM & BLACKBURN CONSTRUCTION CO. LTD.
ARMOURY CLOSE, BORDESLEY GREEN,
BIRMINGHAM, 9
AND HARLEY STREET, BLACKBURN.





HOSLAB
Regd Trade Mark
Laboratory Equipment

WARBURG CONSTANT VOLUME RESPIROMETER
(LEAFLET ON APPLICATION)

CIRCULAR BENCH MODEL
RECTANGULAR MODEL ALSO AVAILABLE

HOSPITAL AND LABORATORY SUPPLIES LTD.
12 CHARTERHOUSE SQUARE, LONDON, E.C.1
COMPLETE LABORATORY FURNISHERS

FOR pH CONTROL

JOHNSONS OF HENDON offer to chemists and manufacturers this useful series of five test papers for the measurement of pH values. UNIVERSAL is one paper covering completely the range from pH 1 to pH 10, enabling pH values to be checked to within 0.5 pH. COMPARATOR test papers make a set of four separate indicators for obtaining still greater accuracy by determining the pH value of any solution to within 0.3 pH.

Descriptive leaflet will be sent free on request.

JOHNSONS OF HENDON LTD.
LONDON, N W 4 ESTABLISHED 1743

THE phenomenal progress of recent years in electrical engineering owes much to the contemporary advances in the design of electrical measuring instruments.

The equipment of a laboratory for making electrical tests can involve an expenditure of hundreds of pounds Likewise the test gear essential to the work of the maintenance engineer can also be a source of considerable expense This difficulty is largely surmounted by using modern *multi-range* testing instruments, which afford maximum usefulness with reasonable initial outlay

"AVO" Instruments are the outcome of many years of successful experience by the pioneers and leading manufacturers of *multi-range* instruments Before leaving our factory, every "Avo" instrument is tested and adjusted to give a high degree of accuracy and constancy of performance

MODEL 7 UNIVERSAL AVOMETER
MODEL 8 UNIVERSAL AVOMETER
MODEL 40 UNIVERSAL AVOMETER
HEAVY DUTY AVOMETER
D C & UNIVERSAL AVOMINORS
"AVO" ELECTRONIC TEST METER
"AVO" ELECTRONIC TEST UNIT
"AVO" VALVE CHARACTERISTIC METER
"AVO" VALVE TESTER
"AVO" WIDE RANGE SIGNAL GENERATOR
"AVO" UNIVERSAL BRIDGE
"AVO" LIGHT METER
"AVO" INDUSTRIAL TEST SET
etc , etc.

Write for a free copy of the latest Comprehensive Guide to "Avo" Instruments

Sole Proprietors and Manufacturers

The Automatic Coil Winder & Electrical Equipment Co. Ltd.
Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1
VICtoria 3404-9

'BORO'
AUTOMATIC BURETTE
with 40 oz. POLYTHENE Storage Bottle
and 10 mill BURETTE in $\frac{1}{10}$ths

Squeeze the Bottle, and Burette
is automatically set at zero Price 25s.

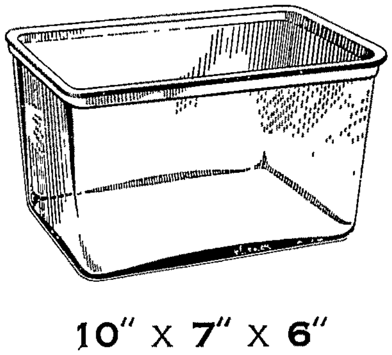
CATALOGUE ON REQUEST
'BORO' Laboratories & Appliance Co., Ltd.
1 Station Buildings, Catford, London, S E 6
HIThe Green 2901

Official repairing agents in Great Britain for Carl Zeiss of Jena and Bausch & Lomb, U.S.A

C&P

SPECIALISTS
IN
MICROSCOPE REPAIRS
ALL BEST MAKES
We manufacture replacement spares, if practicable
B. COOK & S. PERKINS
Pembroke Works, Pembroke Rd., Muswell Hill,
London, N.10 *Telephone* TUDor 9731-2-3

ALL GLASS LABORATORY
TANKS



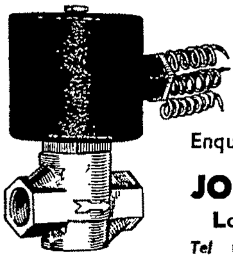
10" x 7" x 6"

Stocks now available once more

6/6 each 70/- dozen

FLATTERS & GARNETT LTD.
309 Oxford Road, Manchester 13
Over 50 Years' Service to Microscopy

Concordia Valves



SOLENOID VALVES
Temperature and Pressure
CONTROLS
Enquiries for special applications invited
JONES & STEVENS LTD.
Long Lane, Littlemore, Oxford
Tel Oxford 77912 Cables Instruments, Oxford

POLAROGRAPHY

The 'Electrochemical Laboratories' Manual Polarographs are designed for plotting polarograms with ease, speed and accuracy

MODEL A. For the analysis of solutions of moderate concentrations

MODEL B MK II. For all polarographic work in industry and research

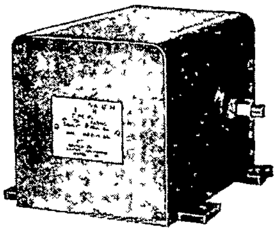
HYDROGEN GENERATOR. D C Power Supply and Electrolytic Cell, giving 2,000 c c H_2 per hour

Full details on request

ELECTROCHEMICAL LABORATORIES
5, Highfield, Wardle Road, Sale, Manchester.
Tel Sale 5851, 6529

SENSITIVE

PRESSURE SWITCH

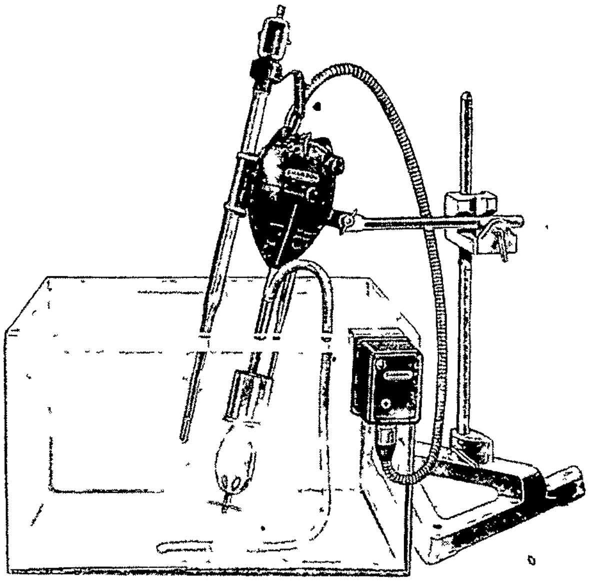


TYPE PV/LI

The Type PV/LI pressure/suction switch operates in the ange from ½ in to 10 in w g , and may be used with non-orrosive gases or liquids in ambient temperatures up to 20° C The instrument uses a large bellows as the pressure ensitive unit, which is coupled through suitable linkages to a heavy duty mercury switch

A catalogue describing the switch shown above and other models is available on request

DELTA TECHNICAL SERVICES LTD
AIRFIELD ROAD KINGSTON-ON-THAMES SURREY
TEL KINgston 9568-9



CIRCOTHERM

Instantly converts any container into a *precision* constant temperature bath or circulating system

Heater, stirrer, pump, adjustable contact thermometer and motor are combined to form a compact unit which can be clamped to any laboratory stand and is supplied complete with mercury switch relay The *built-in pump* serves a two-fold purpose it ensures *an exceptionally uniform temperature through the bath*, it also enables the Circotherm to be used for *supplying constant temperature liquid to outside apparatus* such as refractometers, viscosimeters, other baths, etc

In suitably insulated vessels the temperature can be maintained constant within ±0 01° C

The Circotherm represents the last word in constant temperature equipment in respect of design, versatility and all-round usefulness

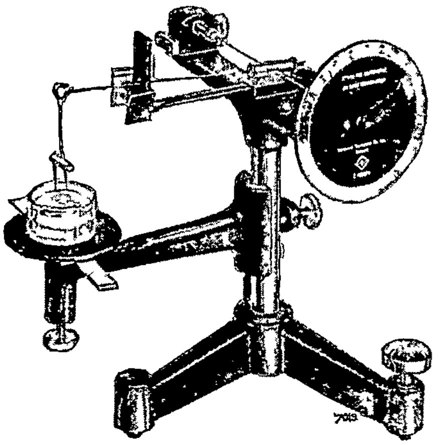
Write or telephone for leaflet with further particulars

SHANDON

6, Cromwell Place, London, S.W.7—KNI. 1131

SURFACE TENSION APPARATUS

AND FOR **INTERFACIAL** SURFACES



Details are given in
SHEET No. 7-N.
May we send a copy ?

THIS apparatus is based upon the design by Dr. P. L. du Nouy, and is used for rapidly and accurately determining the surface tension, or the interfacial tension, of liquids. The method is simple, requires only a small quantity of the substance being tested, and is applicable to practically all kinds of liquids. The instrument is calibrated to read directly in dynes per cm.

CAMBRIDGE INSTRUMENT COMPANY LIMITED
13 GROSVENOR PLACE LONDON S.W.1
WORKS LONDON AND CAMBRIDGE

We Export for Dollars

WM. DAWSON & SONS, LTD.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to All Leading Universities, Public Libraries and Institutions of the World. Catalogues issued

SELLING?

Specialists in Scientific, Technical Books and Publications of all Learned Societies

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephones: Wel. 7948; *Amb.* 5991

and his mining, the vicuna has receded to higher altitudes

The vicuna was plentiful throughout its range in the era of the Inca Imperium. Hunting was only allowed every four or five years under official control, and only adult males were killed, the females being sheared and freed Under the Spanish Colonial regime, hunting was free and, according to reports, about 80,000 vicunas were killed each year in Peru and northern Chile, leading to a considerable decline in numbers After liberation from the Spaniards, the natives returned to the earlier practice of shearing and then freeing the animals Later the decline of the vicuna began again, for the export market demanded vicuna skins, vicuna robes and vicuna wool. The use of firearms destroyed whole flocks, the hunters taking advantage of the females' habit of remaining near the male after he was killed. Thus a whole drove could be slaughtered one after another, and, in this manner, thousands were killed. The wool output of one vicuna gives an average of 500 gm. The superstition that the bezoars (stomach-stones) have a medical and aphrodisiac value may have contributed to the practice of killing the animals, instead of just shearing them

It is difficult to estimate the number of vicunas living to-day In Peru the total number in 1940 was calculated at nearly a million, neither from Bolivia, Chile nor Ecuador has it been possible to get reliable data

Dr de la Tour doubts whether the total number of vicunas reaches a million, and estimates that it is probably not half a million

The first protection measures were carried out by the Inca Imperium when hunting was allowed only every four or five years and then under the strictest control Only the members of the Inca clan were allowed to wear clothes made of vicuna wool or use vicuna robes After liberation from Spain, Bolivar accorded protection to the vicuna by a decree in 1825 During the present century, Peru issued a decree in 1920 prohibiting the sale of vicuna skins and the making of goods from its wool, and Bolivia prohibited the export of vicuna skins

Argentina issued a decree in 1926 prohibiting the unting and exportation of vicunas as well as the ransportation and sale of their skin and fur

There is pressing need for joint action between all ive countries to see that existing laws are tightened ıp and carried out

---

A NEW IDENTIFICATION OF THE FLAME SPECTRA OF THE ALKALINE-EARTH METALS

By Dr C G JAMES and Dr T M SUGDEN

epartment of Physical Chemistry, University of Cambridge

THE characteristic flame spectra given by the alkaline-earth metals have been used extensively n analysis of these elements for many years, despite oubts as to their nature In the cases of calcium nd strontium they are made up predominantly of wo narrow regions for each metal, for calcium at 560-5470 A and 6400-6000 A, and for strontium t 6100-6000 A and 6900-6850 A They have been scribed tentatively to gaseous calcium oxide (CaO) and strontium oxide (SrO) respectively by Pearse and Gaydon[1], although other possible ascriptions have been made by King[2], and by Mahanti[3] Evidence to be given here supports strongly a new hypothesis —that they arise from the radicals CaOH and SrOH, and further that a considerable portion of the radiation in the green given by barium arises from BaOH.

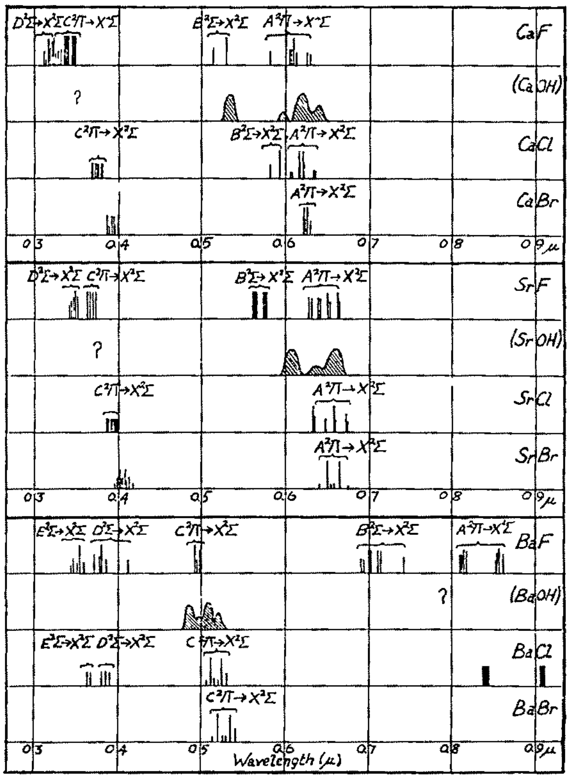


Fig 1 Diagrammatic spectra of the alkaline-earth halide radicals compared with the intense portions of the flame spectra of the alkaline earths

Fig 1 shows diagrammatically the main features of the spectra of the halide radicals of the type of CaF, as listed by Pearse and Gaydon, each system falling into a narrow region presumably because of similarity between the potential energy curves of the contributing states We have inserted between the fluoride and chloride in each case a diagram of the spectrum obtained from these elements in a hydrogen/air flame, using a photoelectric recording device of low resolution in conjunction with a Hilger *E*3 medium quartz spectrograph The correlation of the two regions of strong emission for calcium and strontium with those of the neighbouring halides ($A^2\Pi \rightarrow X^2\Sigma$ and $B^2\Sigma \rightarrow X^2\Sigma$) is very evident

In the case of barium, the corresponding transitions are in the infra-red, and have not been considered Flames containing barium, however, show a zone of diffuse structure, as depicted, near 5000 A., superposed on a background of a much more widespread band system, with more detailed structure This latter, almost certainly due to barium oxide, has been analysed by Mahanti, but the superposed system shows a correlation with the $C^2\Pi \rightarrow X^2\Sigma$ of the halides (Fig 1) Since the hydroxyl group in many ways resembles a halogen atom, it is suggested that the spectra noted arise from the radicals CaOH, SrOH and BaOH

Strong confirmatory evidence is obtained from measurements of the integrated intensity of these spectra in various flames obtained from mixtures of hydrogen, oxygen and nitrogen. A series of such mixtures can be chosen such that after burning in a Mèker type of burner they all give the same (sodium D line reversal) temperature. From the preburned compositions, it is possible to calculate the concentrations [OH] and [O] of hydroxyl radicals and oxygen atoms respectively for thermal equilibrium at the measured temperature of the interconal gases (at atmospheric pressure). If M represents an atom of metal in such gases, then

$$[M_0] = [M] + [M\text{OH}] + [M\text{O}],$$

if the oxide MO and the hydroxide MOH are the only compounds, $[M_0]$ representing the total concentrations in all forms Assuming the chemical equilibria $K_1 = [M]\,[\text{O}]/[M\text{O}]$, and $K_2 = [M]\,[\text{OH}]/[M\text{OH}]$, $[M_0]$ can be expressed in terms of $[M\text{OH}]$

$$\frac{[M_0]}{[M\text{OH}]} = \frac{K_2}{[\text{OH}]} + 1 + \frac{K_2[\text{O}]}{K_1[\text{OH}]}$$

Under these conditions, it is to be expected that the very great majority of the metal is present in the form of the oxide MO, making the first two terms of the above sum negligible[4,5], so that it reduces essentially to

$$\frac{[M_0]}{[M\text{OH}]} \sim \frac{K_2[\text{O}]}{K_1[\text{OH}]}$$

At a given temperature, for a series of flames with constant $[M_0]$ if the intensity I of a band is proportional to $[M\text{OH}]$, then a plot of $1/I$ against the calculated [O]/[OH] should be a straight line passing very nearly through the origin Such a plot is shown (Fig 2) for the 5560–5470 A band from calcium for a series of flames at 2,000° K Similar sets showing such behaviour have been obtained for the other calcium band and the bands from strontium, also with other series at different temperatures In the case of barium, finite intercepts are obtained, probably because of the background, for which it is difficult to correct The flames were all of the shielded type described by James and Sugden[6], and the amount of metal (added as fine sprays of dilute salt solution from an atomizer, the results not depending on the anion) too small to give self-reversal effects. The intensity of the bands, as well as of the resonance line of the metal, varied linearly with the amount added, indicating that they arise from molecules containing only one atom of metal

The much weaker emission found between 3500 and 4500 A for calcium and strontium was effectively constant in intensity with a given series of isothermal flame gases, and may be reasonably ascribed to the calcium and strontium oxides, which can be expected to account for well over 90 per cent of the metal The same is true for the barium flame spectrum outside the narrow limits shown in Fig 1. This method of using series of isothermal flames is therefore capable of giving diagnostic information about the emitters in such cases as this, and provides a valuable tool for the quantitative study of reactions at high temperatures The high intensity of the bands attributed to the radicals CaOH, etc , however, makes it very unlikely that they are present in

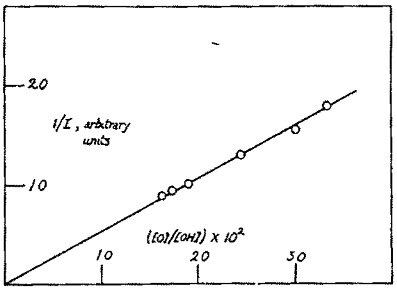


Fig 2 Plot of reciprocal intensity of the intense band in the calcium flame spectrum at 5560–5470 A against calculated [O]/[OH] for flames at 2,000° K

chemical equilibrium, as was assumed in the above scheme, and it is considered probable that they probably arise from collisional processes of metal atoms and OH to give excited molecules which revert to the ground state This would not affect the form of Fig 2, except that the slope of the line would no longer be simply related to equilibrium constants

A detailed account of this work will appear elsewhere. One of us (C G J) is grateful to the Department of Scientific and Industrial Research for a maintenance allowance [Sept 24

[1] Pearse, R W B , and Gaydon, A G , "The Identification of Molecular Spectra' (2nd edit , Chapman and Hall, London, 1950)
[2] King, A S , *Astrophys J* , 27, 353 (1908)
[3] Mahanti, P C , *Phys Rev* , 42, 609 (1932)
[4] Huldt, L , and Lagerqvist, A , *Ark Fys* , 2, 333 (1950)
[5] James, C G , and Sugden, T M (to be published)
[6] James, C G , and Sugden, T M , *Nature*, 171, 428 (1953)

ELECTRIFIED DROPLETS FROM THE BURSTING OF BUBBLES AT AN AIR–SEA WATER INTERFACE

By DUNCAN C. BLANCHARD
Woods Hole Oceanographic Institution, Mass.

THE bursting of a bubble at an air–sea water interface is an effective mechanism for the production of airborne droplets[1,2]. For small bubbles the large majority of these droplets evolve from the vertical water jet which forms upon collapse of the bubble cavity This jet, we have found, moves upward at a high velocity and is transformed into five or six droplets. The height of projection of these droplets, a function of bubble size, may reach a maximum of 18 cm It seems certain that this process significantly contributes to the production of the airborne salt particles present over the oceans

Early in our study of breaking bubbles[1], it was found that the droplets produced by the vertical jet were electrically charged With the apparatus schematically shown in Fig 1, measurements were carried out on the sign and magnitude of this charge as a function of the radius of the droplet Bubbles were produced at a rate of 3–10 sec $^{-1}$ by pumping air under 10–30 lb /sq in. through a finely drawn out section of glass capillary tubing E. These bubbles burst at the surface of the sea water in the inner container F and ejected electrically charged droplets into the observation-region G This region was sealed off from the outside air by an open-bottomed rectangular 'Plexiglass' housing *B* which made contact with the sea water in the outer container *D*. It was necessary to use the outer container as a water seal since the distortion of the water surface near the 'Plexiglass' made it impossible to make observations near the water surface. The d.c. power supply *A* was used for producing a uniform, vertical electric field between the brass plate *C* and the earthed surface of the sea water in the inner container *F* by increasing the plate potential to any desired plus or minus value up to a maximum of 12 kV.

The determination of the electrical charge and radius of a droplet ejected by the jet from a bursting bubble was made in the following way. Before the droplet returned to the water surface, the voltage on the plate was adjusted until the droplet was stationary in the electric field. The gravitational force could then be equated to the electric force, giving an equation with two unknowns, the droplet radius and charge. The field-strength was then decreased to allow the droplet to move slowly downward. An equation of motion could then be obtained which, when solved simultaneously with the first equation, gave the droplet radius and charge. A cathetometer was used for observing the droplet and to determine its motion in the electric field. To avoid evaporation of the droplet while under observation, it was necessary that the air and water temperature were essentially the same.

All the results obtained to date, including those shown in Fig. 2, were from bubbles less than about 150 μ in radius the ejected droplets of which rose less than 20 mm. The weight of salt contained in droplets produced from this range of bubbles is comparable to that found by Woodcock[3] over the oceans. Curve A of Fig. 2 is for droplets from bubbles which were allowed to break in the presence of an electric field. In this manner all the droplets originating via the jet mechanism obtained, by electrostatic induction, a charge of opposite sign from that of the plate potential. For a given droplet radius, this charge was substantially the same in the range of fields from 50 to 300 V. cm.$^{-1}$. Curves *B*, *C* and *D* are for the natural charge on the droplets. In these cases the bubbles were allowed to produce droplets before the balancing electric field was applied. It will be noted that the results, unlike those for the induced charges tend to fall into three separate groupings. The first, for droplets less than 3μ radius, indicates an increase of charge nearly proportional to the fifth power of the radius. The second, for droplets between 3 and 6μ in radius, shows approximately a second-power relationship. Other results suggest that this curve is not unique but that a family of curves exists in this region. The third grouping, for droplets greater than 6μ radius, is similar to the second. The maximum charge per unit volume is obtained by droplets of about 3μ radius. At this radius the quantity of charge is nearly identical with that obtained when the bubbles break in the presence of an electric field. To date no explanation has been given for these groupings.

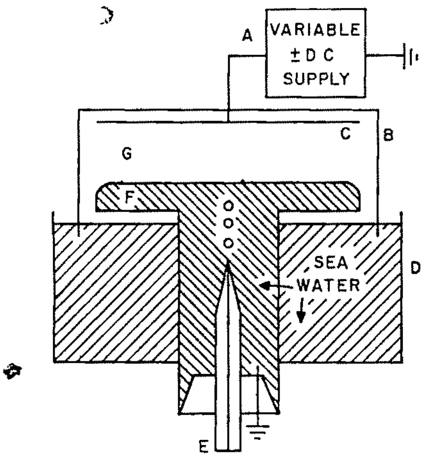


Fig. 1. A schematic view of the apparatus for suspending an electrically charged droplet in a vertical electric-field

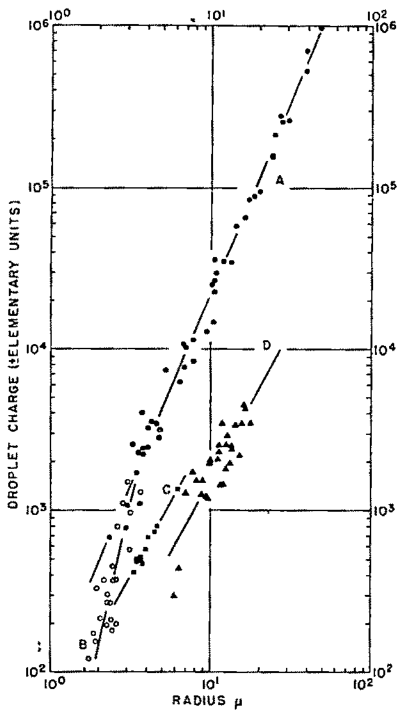


Fig 2. Natural and induced charge on droplets from bursting bubbles

If the maximum height of ejection of droplets is less than about 2 mm., the sign of the charge on all the drops is, almost without exception, positive. For ejection heights of 2–20 mm., which implies larger bubbles, the charge on the droplet ejected to the maximum height is still positive, while the lower droplets may show either sign.

These results lead to some very interesting speculations as to what might happen under various natural conditions. Consider, for example, a thunderstorm passing over the sea with a peak field-strength at the sea surface of 100 V. cm.$^{-1}$. From curve *A* of Fig. 2, one finds that all droplets less than 10 μ in radius originating from the jets of breaking bubbles will be carried upward towards the cloud. One might also wonder about the electric field at the surface of these droplets and its tendency to induce corona discharge. With the equation of curve *A* and Gauss's law, one finds that the field strength E (V. cm.$^{-1}$) at the surface of a droplet of radius R (microns) is $E = 1{\cdot}24 \times 10^3 R^{0{\cdot}4}$. With E varying only as the 0·4 power of the radius, the field-strength at the surface of droplets 3–50μ radius varies only from about 1,900 to 5,900 V. cm.$^{-1}$. These calculations assume that the charge is uniformly distributed over the surface of the drop. It is well known that a charged conducting sphere in a vertical electric field will have an intensification of the field on the top and bottom of the sphere. This intensification was computed, with Laplace's equation, for the droplets of curve *A* when they are subjected to an electric force just sufficient to balance the gravitational force. The computed fields were in no case more than 15 per cent larger than those given above. These fields are not sufficient for breakdown; but evaporation of the droplets, which almost invariably occurs under natural conditions, might raise the surface field to breakdown values.

It is likely that the positively charged droplets from the smallest bubbles alone carry an appreciable electrical current between the atmosphere and the earth. If one assumes a positive charge totalling 3,000 elementary units carried by the several droplets from a small bubble and, on the average, about one bubble per second per square centimetre breaking over the entire ocean area of the world, then a current of 1,800 amp. will be obtained. It is assumed, of course, that winds and turbulent diffusion will transport these small droplets upward. This current is of the same magnitude but in the opposite direction to the observed current-flow in fair-weather areas over the earth[4]. It is probable that the above estimate of the current carried by these low-mobility droplets is high, but, nevertheless, this mechanism may contribute significantly to the earth's counter or supply current, which at present is attributed to thunderstorms.

Further laboratory- and field-studies should lead to other interesting aspects of this production of charge on droplets from bubbles breaking at the sea surface. This work is being continued, and more detailed publication is planned for the future.

This work was supported by the Office of Naval Research, under contract number *Nonr*-798(00) (*NR*-082-124).

[Oct. 6.

---

[1] Woodcock, A. H., Kientzler, C. F., Arons, A. B., and Blanchard, D. C., *Nature*, **172**, 1144 (1953).

[2] Knelman, F., Dombrowski, N., and Newitt, D. M., *Nature*, **173**, 261 (1954).

[3] Woodcock, A. H., *J. Meteor.*, **10**, 362 (1953).

[4] Gish, O. H., "Compendium of Meteorology", 101 (Waverley Press, Inc., 1951).

OCCURRENCE OF A NEW BASE IN THE DEOXYRIBONUCLEIC ACID OF A STRAIN OF *BACTERIUM COLI*

By D. B. DUNN and Dr. J. D. SMITH

Agricultural Research Council Plant Virus Research Unit, Molteno Institute, Cambridge

THE thymine-requiring strain of *Bacterium coli*, 15 T^-, was first described by Cohen, who has examined in detail several aspects of its physiology[1]. One of the most interesting observations was that, when placed in a synthetic medium lacking thymine, the cells will only survive 15–20 min. before rapidly losing their viability.

We have found that when grown under conditions of thymine deficiency or in the presence of 5-aminouracil or 2-thiothymine, *B. coli* 15 T^- produces a type of deoxyribonucleic acid containing considerable amounts of a new base. This base is also found in small amounts in the deoxyribonucleic acid from cells grown in excess of thymine and also from *B. coli* B.

B. coli 15 T^- was grown on a glucose – ammonium sulphate synthetic medium supplemented with thymine. The addition of the thymine analogues 5-aminouracil (10^{-3} *M*) or 2-thiothymine (2×10^{-3} *M*) to cells at a density of 2×10^{8}/ml. in medium containing 2·5 μgm./ml. thymine produced inhibition of growth, measured turbidimetrically, beginning after 90 min. (two generation times), and finally resulted in the formation of long bacterial filaments. These effects were completely reversed by the addition of 100 μgm./ml. thymine simultaneously with the inhibitor. Long bacterial filaments were also formed after growth in a thymine-deficient medium (0·2–0·5 μgm./ml.).

Deoxyribonucleic acids were prepared[2] from bacteria grown in the presence of 5-aminouracil, 2-thiothymine, or in low concentrations of thymine, and were hydrolysed in 72 per cent w/w aqueous perchloric acid[3], and the bases separated by two-dimensional paper chromatography in *iso*propanol–water–hydrochloric acid[4] and *iso*propanol–water–ammonia[5]. Unlike the 5-halogenated pyrimidines[6], 5-aminouracil and 2-thiothymine are not incorporated into *B. coli* 15 T^- deoxyribonucleic acids. However, all three nucleic acids gave, in addition to the four usual bases, a fifth ultra-violet-absorbing spot (*X*) which ran with cytosine in *iso*propanol–water–hydrochloric acid and slightly ahead of thymine in *iso*propanol–water–ammonia. *X* was also released from the nucleic acid after hydrolysis for 1 hr. at 55° in *N* hydrochloric acid. In this latter respect it behaved like the purines adenine and guanine.

The ultra-violet absorption maxima and minima of *X* are given in Table 1. Measurement of the change in spectrum over the *p*H range 0–14 indicated the presence of two dissociations with *pK* values of approximately 4 and 10, respectively. The presence of a basic dissociation (*pK* about 4) was shown by paper electrophoresis at *p*H 2·5 and 3·5, when *X* migrated towards the cathode. Its high R_F values in butanol–water–ammonia[7] and *iso*propanol–water–ammonia (Table 1) suggested that *X* possibly contained an alkyl group.

As at first we considered that *X* was likely to be an alkylated pyrimidine bearing a basic group, we compared it with a number of pyrimidines including 5-aminouracil, 5-methylaminouracil, 5-dimethylaminouracil, 5-amino-1-methyluracil, 5-amino-4-methyluracil and 4-amino-5-methyluracil. It soon became apparent that *X* behaved more like a purine than a pyrimidine, and after comparison with several purines (including 2-methyladenine, 6-methylpurine, 8-methylpurine and 6-ethylaminopurine) we found that 6-methylaminopurine[8] was identical with *X* in its ultra-violet absorption spectrum, its chromatographic movement in five different solvents and its electrophoretic mobility at *p*H 2·5 and 3·5 (Table 1). On heating at 120° in 6 *N* hydrochloric acid for 18 hr., both *X* and 6-methylaminopurine were converted into substances which did not absorb ultra-violet light. These on paper chromatography in butanol–water–formic acid, *iso*propanol–water–ammonia or *iso*propanol–water–hydrochloric acid were in each case shown to contain two ninhydrin-reacting substances one of which corresponded to glycine. On hydrolysis with strong hydrochloric acid the purine ring is known to break down, giving

Table 1 PROPERTIES OF *X*, 6-METHYLAMINOPURINE AND CERTAIN OF THEIR DERIVATIVES

R_F values in	*X*	6-Methyl-aminopurine	Adenine	*X* deoxyriboside	Product formed by the action of nitrous acid on	
					X	6-methyl-aminopurine
*Iso*propanol–water–hydrochloric acid (ref 4)	0 61	0 61	0 50			
*Iso*propanol–water–ammonia (ref 5)	0 71	0 71	0 56	0 80		
n-Butanol–water–ammonia (ref 7)	0 53	0 51	0 29			0 46
n-Butanol–water–formic acid (ref 7)	0 33	0 33	0 18		0 68	0 68
Ammonium sulphate–sodium acetate–water–*iso*propanol (ref 5)	0 22	0 24	0 23			
Electrophoretic mobility (cm /hr) at 20 V /cm						
*p*H 2 5	10 1	10 4	10 8			
*p*H 3 5	6 7	6 9	9 0	3 1		
Ultra-violet absorption maximum (mμ)						
*p*H 1	267	267	262	265	264*	267*
*p*H 7	267	266	260	266		
*p*H 13	273	273	267	266	274	273
Ultra-violet absorption minimum (mμ)						
*p*H 1	233	232			233	233
*p*H 13	239	239			241	241

* The absorption maximum of this compound is very flat

glycine, carbon dioxide, carbon monoxide and ammonia[9] Both *X* and 6-methylaminopurine form insoluble silver and cuprous salts[10] a characteristic of some purines. Treatment with sodium nitrite in acetic acid converts *X* into a substance differing from *X* in its chromatographic behaviour and no longer bearing a positive charge at *p*H 3 5, so it does not migrate on electrophoresis With this reagent, 6-methylaminopurine gives a product which is presumably 6-methylnitrosaminopurine. This is indistinguishable from the compound formed from *X* in its chromatographic movement in butanol–water–formic acid, its electrophoretic behaviour at *p*H 3 5 and its ultra-violet absorption spectrum (Table 1).

We have also isolated, from 15 T^- deoxyribonucleic acid containing *X*, a substance with the expected properties of the nucleoside of *X*. The nucleic acid was treated with deoxyribonuclease and rattlesnake venom diesterase and 5′-nucleotidase, and the hydrolysate run on paper chromatograms in *iso*propanol–water–ammonia. The deoxyriboside of *X* runs ahead of thymidine and the free base *X*. On paper electrophoresis at *p*H 3 5, it runs more slowly than *X* because of the greater frictional resistance of the larger molecule At *p*H 1 and 7 its ultra-violet absorption spectrum is similar to that of *X* , but, unlike *X*, the maximum does not shift to the longer wave-lengths at *p*H 13 (Table 1). On treatment with *N* hydrochloric acid at 55° for 1 hr. it is converted to a substance identical with *X*.

A more careful examination of deoxyribonucleic acid from bacteria grown in excess of thymine showed that these contained small amounts of *X* amounting to about 0 4 per cent of the total bases Quantitative analysis of deoxyribonucleic acids from bacteria grown in the presence of 5-aminouracil, 2-thiothymine, or low concentrations of thymine, showed that, in comparison with nucleic acid from bacteria grown in excess of thymine, the former contained about 20–30 per cent less thymine relative to the other bases, and that this deficiency was almost quantitatively accounted for (on a molar basis) by the amount of *X* present. In these nucleic acids the amount of adenine was also decreased by about 5 per cent.

Table 2 MOLAR PROPORTIONS OF PURINES AND PYRIMIDINES IN DEOXYRIBONUCLEIC ACIDS OF *B coli* 15 T^- GROWN UNDER DIFFERENT CONDITIONS

Conditions of bacterial growth	Total bases (moles/100 moles)				
	Adenine	Guanine	Cytosine	Thymine	*X*
25 μgm /ml thymine	23 6	27 5	26 2	22 4	0 4
1 5 μgm /ml thymine + 10^{-4} *M* 5-amino-uracil	22 3	27 6	26 6	19 1	4 2

We conclude that the new base *X* is 6-methylaminopurine This has already been shown to replace adenine in the growth of *Lactobacillus casei*[11], and by studying the effect of this substance in the nucleic acid metabolism of *B. coli* 15 T^-, we hope to discover the reason for its appearance in the deoxyribonucleic acids under conditions of thymine deficiency The fact that 6-methylaminopurine apparently replaces thymine residues in the nucleic acid is extremely difficult to reconcile with the theory of replication proposed by Watson and Crick on the basis of their structure for deoxyribonucleic acid[12] and may mean that the nucleic acid formed is abnormal in other respects. In fact, it was for this reason that we first compared *X* with a number of 4- and 5-substituted pyrimidines in order to eliminate the possibility that it might be a pyrimidine so substituted as to make its deoxyriboside behave like a purine deoxyriboside towards acid hydrolysis

We wish to thank Dr. S S Cohen for the culture of *B coli* 15 T^-, Dr. D J Brown and Dr. D. M Brown for gifts of chemicals and Dr. E Lester Smith and Dr. A M Michelson for chemical advice. One of us (D B. D) wishes to thank the Agricultural Research Council for a studentship held during the course of this work. [Dec. 9.

[1] Barner, H D , and Cohen, S S , *J Bact* , 68, 80 (1954) Cohen, S S , and Barner, H D , *Proc U S Nat Acad Sci* , 40, 885 (1954).

[2] Gandelman, B , Zamenhof, S , and Chargaff, E , *Biochim et Biophys. Acta*, 9, 399 (1952) Smith, J D , and Wyatt, G R , *Biochem J* , 49, 144 (1951)

[3] Marshak, A , and Vogel, H J , *Fed Proc* , 9, 85 (1950)

[4] Wyatt, G R , *Biochem J* , 48, 584 (1951)

[5] Markham, R , and Smith, J D , *Biochem J* , 52, 552 (1952)

[6] Dunn, D B , and Smith, J D , *Nature*, 174, 305 (1954)

[7] Markham, R , and Smith, J D , *Biochem J* , 45, 294 (1949)

[8] Elion, G B , Burgi, E , and Hitchings, G H , *J Amer Chem Soc* , 74, 411 (1952) Mason, S F , *J Chem Soc* , 2071 (1954)

[9] Strecker, A , *Ann Chem u Pharm* , 146, 142 (1868)

[10] Reguera, R M , and Asimov, I , *J Amer Chem Soc* , 72, 5781 (1950) Holdsworth, E S (unpublished)

[11] Hitchings, G H , Elion, G B , Falco, E A , Russell, P B , and Van der Werff, H , *Ann N Y Acad Sci* , 52, 1318 (1950)

[12] Watson, J D , and Crick, F H C , *Nature*, 171, 737 and 964 (1953)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Endocrine Chain in an Insect

It is now well recognized that growth and moulting in the insect are initiated by a hormone produced in the neurosecretory cells of the brain. This brain factor activates the thoracic gland, which is then believed to secrete the definitive growth and moulting hormone[1]. But the possibility remains that there may be yet further links in the chain of endocrine organs, located in the abdomen.

The œnocytes and the dermal glands have already been excluded[2], but the pericardial cells and the various types of hæmocytes are obvious possibilities. Blockage of the hæmocytes by the injection of Indian ink into the 4th-stage larva of *Rhodnius* at one day after feeding causes a delay in moulting which may range from one to three or four weeks beyond the normal fourteen days. Blockage of the pericardial cells with trypan blue has no effect—unless sufficient is injected to fill the hæmocytes also. Similar results are obtained with iron saccharate.

These injections no longer cause any great delay if made later than the third day after feeding (Fig. 1): clearly they interfere with the initiation of mitosis in the epidermis (which begins at the fourth or fifth day), not with the ordinary processes of intermediary metabolism. The detailed study of the hæmocytes in *Rhodnius* is not yet complete, but there is already histological evidence of secretory activity becoming evident on the fourth day after feeding.

Butenandt and Karlson[3] have recently succeeded in isolating in crystalline form from the pupæ of the silkworm an active principle which will induce puparium formation in *Calliphora* and which, as proved by Williams[3], will cause renewed development in the diapausing pupa of *Platysamia*. Through the kindness of the German authors I have been able to test the activity of their hormone on *Rhodnius* and have found that 0·5–0·75 μgm. injected into the decapitated 4th-stage larva at twenty-four hours after feeding (weight about 80 mgm.) will induce moulting. In *Rhodnius*, as in *Platysamia*, the hormone is equally effective when injected into the isolated abdomen. This suggests, as Butenandt and Karlson point out, that it is the active principle of the thoracic gland. But in view of the observations reported in this communication, the possibility remains that it may be a product of the hæmocytes. That possibility is favoured by the observation that moulting induced by injection of the hormone is not delayed by blockage of the hæmocytes with Indian ink or iron saccharate.

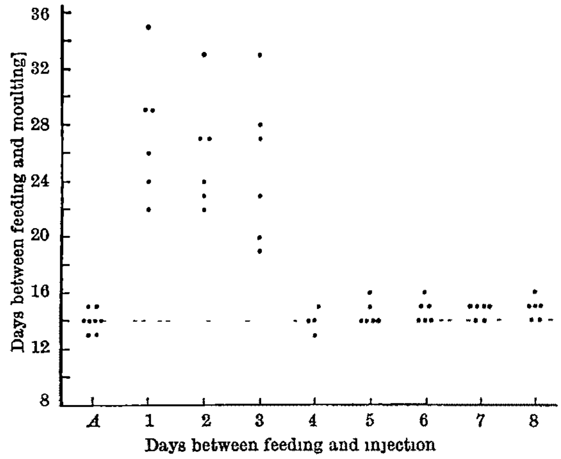


Fig. 1. Effect of blockage of the hæmocytes on the time between feeding and moulting in the 4th-stage larva of *Rhodnius*. 5 mm.^{3} of 2 per cent iron saccharate was injected into batches of six larvæ on the first to the eighth day after feeding. *A*, control batch of eight which received no injection

V. B. Wigglesworth

Department of Zoology,
Cambridge. Jan. 10.

---

[1] Wigglesworth, V. B., "The Physiology of Insect Metamorphosis" Mon. of Exp. Biol., No. 1 (Cambridge, 1954).

[2] Wigglesworth, V. B., *Quart. J. Micro. Sci.*, 77, 191 (1934).

[3] Butenandt, A., and Karlson, P., *Z. Naturforsch.*, 9*b*, 389 (1954).

A Critical Response to Changing Length of Day in an Insect

In British populations of the emperor dragonfly, *Anax imperator* Leach, the final larval instar is usually entered in August. A diapause follows, and metamorphosis is postponed until the following spring. In this way, emergence of the adult is closely synchronized[1].

Close inspection of the time-frequency distribution of emergence has shown it to be bi-modal, and it has been established that the larvæ emerging in any one year are of two distinct types.

The first, major emergence group (Fig. 1, *A*) is composed of larvæ which have entered the final instar the previous year and have since completed diapause. The second emergence group (Fig. 1, *B*), which is developed to a variable extent from year to year, and which seldom comprises more than 10 per cent of the annual population, is made up of larvæ which have over-wintered in the penultimate larval instar, entered the final instar in spring, and emerged shortly afterwards.

That larvæ of the second group metamorphose without delay demonstrates that the diapause in the final instar must be facultative, being induced in summer and autumn, yet being averted in spring. In Nature, it was found that the latest date upon which the final instar was entered by a larva destined to forgo diapause was May 28. Since the duration of metamorphosis is known, a further check is provided by the latest dates of emergence, which are closely similar from year to year. From three years of observations there is strong evidence for concluding that diapause is averted in larvæ entering the final instar before June 1, but is induced after that date.

The seasonal incidence of diapause suggests that the environmental factor responsible for its determination is likely to be the sign of change in successive lengths of day. Preliminary experiments conducted in 1952 have lent support to this thesis. In these experiments, larvæ experiencing unchanging photoperiods of a length corresponding to July 31 responded in a fashion similar to those subjected to a regime of decreasing lengths of day, both groups entering diapause.

This observation suggests that, when daily increments fall below a certain threshold value, they are no longer appreciated as such, but are recorded by larvæ as being of constant length, until such time after the summer solstice as decrements begin to

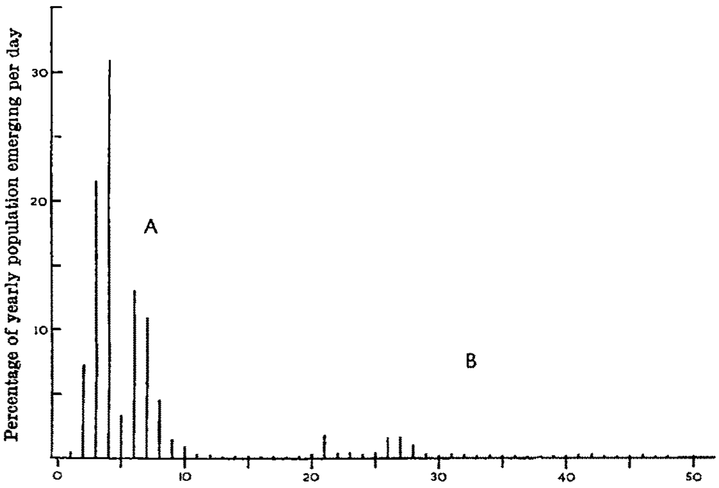


Fig 1 Time-frequency distribution of adult emergences in a population of *Anax imperator* during 1952 *A* Main emergence group provided by larvæ which had completed diapause *B* Subsidiary emergence group provided by larvæ in which diapause had been averted Emergence began on May 17 and finished on July 5

exceed the threshold. If this is so, then the observation that diapause is induced after June 1 means that larvæ are unable to discern increments of less than about two minutes *per diem*

Spring species have been defined as those possessing a diapause in the final larval instar[1]. For the diapause to be determined facultatively obviates the necessity for larvæ entering the final instar in spring to postpone emergence for one year , but, at the same time, it extends the emergence period The extent to which the emergence period is lengthened will depend upon the value of the threshold increment of length of day that evokes a response Members of a spring species in which diapause has been averted will possess the properties of summer species. Thus, in the first emergence group of *A. imperator*, emergence is closely synchronized whereas, in the second, it is temporally dispersed (see Fig. 1).

A imperator is thought to be the first invertebrate in which a response to changing, rather than absolute, photoperiod has been discerned. It is noteworthy that previous studies on diapause have involved uni- or multi-voltine animals For species having a larval duration of more than one year, it is probable that some factor more incisive than absolute photoperiod is required as a seasonal indicator. It is therefore likely that a similar response exists in other long-lived invertebrates of temperate regions

This work was financed by the Department of Scientific and Industrial Research and is to be described more fully elsewhere

PHILIP S. CORBET

Department of Zoology, Downing Street,
Cambridge. Sept 20

[1] Corbet, P S , *Nature*, 174, 655 (1954) , erratum, 174, 777 (1954)

A Model of Cortical Activity

IN a study of the organization of the cerebral cortex, alternative experiments on the evoked potentials of the hippocampus and of the isocortex were performed in order to apply the findings in the more simply constructed layer of Ammons pyramids to resolution of the electrical fields of the cortex proper. The former consists essentially of one layer of similarly oriented cells, whereas the latter structure shows duplication in the form of stratified supragranular and infragranular layers We have found that the electrical correlates of the layered isocortex are not in the direction that at first seemed obvious For one thing, the d c standing potential across the unstimulated isocortex is less rather than greater than that across the pyramid cell-layer of the hippocampus, suggesting that the cell dipoles are not arranged in series. Furthermore, the overall potentials of activation of an area of the isocortex show an increase in magnitude during inactivation of the supragranular layer

A consideration of some well-known facts will indicate the manner of derivation of the model The supragranular layer is more variable than the infragranular, both between species[1] and between neighbouring cortical regions in the same species (unpublished work). The infragranular layers are everywhere more uniform, suggesting a protean function. The experiments of Murphy and Dusser de Barenne[2] show that motor function survives the destruction of the supragranular layers of the precentral cortex and demands only the integrity of the deep cells. This suggests that the topmost part of the cortex may be regulatory Morphologically, the characteristic and unique type of cortical cell, the pyramids, has in its apical dendrite a feature which has not been accounted for in any previous model of cortical function

In Fig. 1 is illustrated our finding that there is a release of the isocortex, in the reaction to an afferent

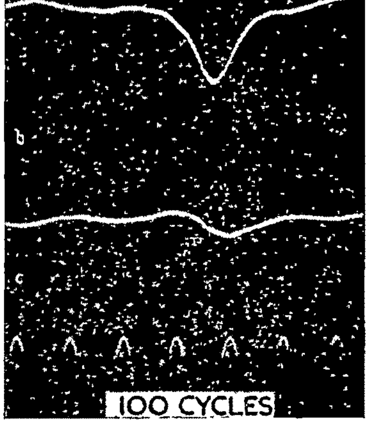


Fig 1 Sequence of records from the sensory cortex of a rabbit evoked by stimulation of the sciatic nerve (*a*) before, (*b*) during, and (*c*) after narcotization of the cortex with cyanide applied to the pial surface Time in milliseconds

stimulus, following narcotization of the supragranular layers This has been seen to occur with a variety of narcotic and poisonous agents, and in cortical activity evoked by stimulation of various afferent sources as well as via the corpus callosum Rendering the surface layers of the isocortex subnormal by adequate stimulation has resulted in a similar release, or augmentation, of the activity

To account for these experimental facts and to harmonize with the other relevant observations, we propose the following model of cortical activity The potential differences maintained across the cell bodies of the cortical neurons are a measure of their polarization and regulate the firing pattern Because the cortical cells have apical dendrites ramifying in the molecular layer, the successive tiers of cells are not in series, in so far as their electrical fields are concerned Instead, the external current flow of the cells of one layer tend to reverse the polarization of members of the other and thus modulate their impulse discharge. In this way, the small and medium-sized pyramids of the supragranular layer act as a ballast to the efferent cells and inhibit their activation by the afferents When the supragranular layer is thrown out of action, the cortical response is more vigorous

The mechanism which we are postulating does not require the degree of discrete signal transference from cell to cell which is widely assumed In this respect it fits in well with the results of our studies, for we have found, as Jasper (ref 3, p 146) has previously remarked, that cortical discharges evoked by stimulation of afferent pathways are surprisingly uncomplicated and uniform events. Such a fact is hard to reconcile with the idea that discrete bits of information trickle through the cortex. Thus both our findings and our interpretation lend support to those who feel that the relation of cortical activity to so complex a phenomenon as mentation must involve dynamic sequences such as the moving domains of Cragg and Temperley[4]

J. SUTIN
B CAMPBELL*

Department of Anatomy,
University College,
London, W C 1 Aug. 20.

* On leave from the University of Minnesota, 1953–54

[1] Mott, F W, *Arch Neurol*, 3, 1 (1907)
[2] Murphy, J P, and Dusser de Barenne, J G, *J Neurophysiol*, 4, 147 (1941)
[3] Jasper, H H, in "Nerve Impulse", edit by Merritt, H H (Josiah Macy Foundation, New York, 1952)
[4] Cragg, B G, and Temperley, H N V, *E E G Clin Neurophysiol*, 6, 85 (1954)

Sialic Acids

IN 1936[1] one of us (G B) isolated from bovine submaxillary mucin a crystalline reducing acid, later[2] named 'sialic acid'. Qualitative reactions indicate that sialic acid or substances closely related to it occur in most epithelial mucins, in ovomucin, in the glycoproteins of blood serum and in gangliosides[3] Crystalline substances reacting like sialic acid have now also been isolated from porcine, ovine and equine submaxillary mucin None of these products is, however, identical with any of the others—a fact already evident from the X-ray powder diagrams (Fig 1).

Fig 1 X-ray powder diagrams of (*a*) bovine, (*b*) ovine, (*c*) porcine and (*d*) equine sialic acid

The bovine sialic acid crystallizes in monoclinic rectangular plates, the others in needles or prisms Although each substance appears microscopically uniform and invariably gives in different preparations the same X-ray diagram, elementary analyse have not given values consistent enough to establis definitely the compositions. The most probabl compositions are

Bovine sialic acid, $C_{13}H_{23}NO_{11}$ (or $C_{13}H_{21}NO_{10}$ H_2O)
Porcine „ „ $C_{11}H_{19}NO_{10}$
Ovine „ „ $C_{11}H_{19}NO_9$

(The purified equine substance has not yet bee obtained in quantities sufficient for elementar analysis)

Bovine sialic acid contains an N-acetyl group, an an O-acetyl group which is very easily split off Th ovine substance has only an N-acetyl group, and th porcine acid no acetyl group but instead an N glycolyl group. The glycolic acid was isolated an identified as the calcium salt.

Periodate splits off one primary alcohol group fro sialic acids On treatment with concentrate sulphuric acid, carbon monoxide is liberated—rath less than one mole per mole for bovine and ovi sialic acids and rather more than one mole per mo for the porcine substance This probably indicat the presence of an α-hydroxy-group in each of the and accounts for the glycolic acid in the porci sialic acid

Titration with hypoiodite, as described by Wil staetter-Schudel, indicates the presence of an aldehyde group. This conforms with the finding tha on treatment with sodium borohydride approx mately one molecule of hydrogen is taken up pe molecule of sialic acid. The Schiff reaction wit fuchsin-sulphurous acid (as modified by Tobie[4] however, is only very faintly positive for bovi sialic acid, and is negative for the other two

After reduction of sialic acid with sodium borohydride, subsequent treatment with dilute hydrochloric acid at 100° produces no reducing substance This almost excludes the presence of a glycosidi linkage in the molecule The presence of three end groups and the almost certain absence of a glucosidi linkage suggest a branched carbon chain in the molecule The infra-red spectra have given no additiona clue to the structure Only end-absorption startin at about 2500 A. is seen in the ultra-violet.

The optical rotations of the ovine and porcin sialic acids remain constant at room temperature whereas that of the bovine acid changes very slowly probably owing to decomposition or ring-formation The substances melt with simultaneous decomposition, already showing some browning below the decomposition point

	$[\alpha]_D$	Decomp point
Bovine sialic acid	+ 8° ± 2°	152–153° (uncorr)
Porcine ,, ,,	− 31° ± 2°	185–187° ,,
Ovine ,, ,,	− 32° ± 2°	185–187° ,,

The 2-carboxy-pyrrole found by Gottschalk[5] as a product of splitting on alkaline hydrolysis of submaxillary mucin is no doubt formed by a cyclization process during the alkaline decomposition of sialic acid The neuraminic acid of Klenk[6], the hæmataminic acid of Yamakawa and Suzuki[7], and the lactaminic acid of Kuhn[8] obviously all bear a very close relation to sialic acid The first two probably simply represent de-acetylated sialic acids.

A detailed report of this work will appear elsewhere

Note added in proof. The assumption of the presence of a branched carbon chain in the sialic acid molecule has received additional support by recent micro hydroxyl-group determinations. These revealed six hydroxyl groups per molecule in the porcine sialic acid and five in that of the bovine substance.

G Blix
E Lindberg
L Odin
I Werner

Institute of Medical Chemistry,
University of Uppsala Oct 27

[1] Blix, G , *Z physiol Chem* , **240**, 43 (1936)

[2] Blix, G , Svennerholm, L , and Werner, I , *Acta Chem Scand* , **6**, 358 (1952)

[3] Werner, I , and Odin, L , *Acta Med Soc Upsal* , **57**, 230 (1952)

[4] Tobie, W C , *Indust Eng Chem* , **14**, 405 (1942)

[5] Gottschalk, A , *Nature*, **174**, 652 (1954)

[6] Klenk, E , *Z physiol Chem* , **268**, 50 (1941)

[7] Yamakawa, T , and Suzuki, S , *J Biochem , Japan*, **38**, 199 (1951)

[8] Kuhn, R , and Brossmer, R , *Ber deut chem Ges* , **87**, 123 (1954)

Biological Decomposition of Aromatic Nitro-compounds

Certain organic nitro-compounds, for example, chloramphenicol, are known to arise biologically , but very little is known about the transformation of this class of compounds by micro-organisms Erikson[1] and Moore[2] found that certain Actinomycetes could utilize picric acid, trinitroresorcinol, and nitrobenzene, and Simpson and Evans[3] have reported briefly on species of *Pseudomonas* that decompose *o*- and *p*-nitrophenol with the formation of nitrite , the last workers also mention nitrite production from 2,4-dinitrophenol and chloramphenicol

According to a personal communication from Mr H. Ingvard Petersen (Government Weed Research Department, Lyngby, Denmark), the herbicide dinitro-*ortho*-cresol is rapidly inactivated in soil, apparently by biological agencies, whereas the chemically related herbicide dinitrobutylphenol appears more persistent From the soil used in these detoxication experiments, we have isolated an organism that decomposes 4,6-dinitro-*ortho*-cresol and several related compounds with release of nitrite

The organism appears in young cultures as a non-spore-forming, Gram-positive, irregular rod, approximately 1 4–4 0 μ × 0 6–0 8 μ, in characteristic angular or parallel arrangements , the cells in older cultures become shorter or almost coccoid, 0 7–1 3 μ in diameter Taxonomically, it seems to be an atypical form of *Corynebacterium simplex*[4]. Decomposition of dinitro-*ortho*-cresol in solution as well as in agar medium is evidenced by the bleaching of the yellow colour and the appearance of nitrite. Growth is possible in a synthetic medium with no other organic constituents than 0·01–0 05 per cent dinitro-*ortho*-cresol (as sodium salt), but is slow and unreliable under these conditions , addition of 0 01–0 1 per cent yeast extract greatly accelerates growth and nitrite formation The results of an experiment in liquid medium with 0 02 per cent dinitro-*ortho*-cresol and 0 01 per cent yeast extract are shown in Fig. 1. (Nitrite and residual dinitro-*ortho*-cresol were both determined colorimetrically on a Coleman spectrophotometer, the former by means of the Gries reagent, the latter directly by the intensity of the yellow colour.)

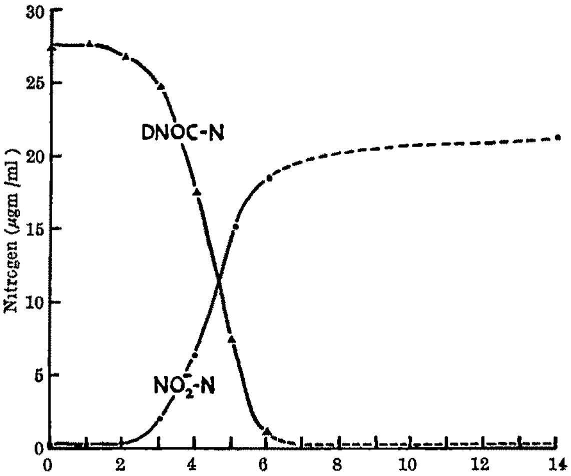


Fig 1 Production of nitrite from dinitro-*ortho*-cresol (approx 10^{-3} *M*) by *Corynebacterium* sp (*simplex* ?) in liquid medium incubated at 25° C

Besides 4,6-dinitro-*ortho*-cresol, the organism decomposes *p*-nitrophenol, 2,4-dinitrophenol, and 2,4,6-trinitrophenol (picric acid), but not *o*- and *m*-nitrophenol, 2,5- and 2,6-dinitrophenol or 3,5-dinitrobenzoic acid. Thus only compounds with a nitro-group in the *para*-position appear liable to attack , we have not, however, been able to detect nitrite formation from 4,6-dinitrobutylphenol, which also seems to be less readily inactivated in soil, as mentioned above The results in Fig. 1, as well as similar experiments with dinitrophenol, show that more than half the nitrogen in dinitro-compounds is converted into nitrite, that is, both nitro-groups are metabolized Possibly the *p*-group represents the point where the enzymatic attack begins and the ring-structure is broken, with subsequent release of the second nitro-group

The results of these experiments will be published in detail elsewhere

H L Jensen
K Gundersen

State Laboratory for Plant Culture,
Department of Bacteriology,
Lyngby, Denmark
Oct 25

[1] Erikson, D , *J Bact* , **41**, 277 (1941)

[2] Moore, F W , *J Gen Microbiol* , 3, 143 (1949)

[3] Simpson, J R , and Evans, W C , *Biochem J* **55**, (*2*), xxiv (1953)

[4] Bergey, D H , "Manual of Determinative Bacteriology" (Baillière, Tindall and Cox, London, 6th edit , 1948)

Meaning of 'Turnover' in Biochemistry

HEVESY[1] considers the determination of the rate of renewal, or turnover, as one of the most important applications of tracers A clear definition of the term 'turnover' is therefore of obvious interest. In the present literature the term 'turnover' is used with two different meanings This leads to confusion.

Zilversmit, Entenman and Fishler[2], and later other workers in Chaikoff's laboratory[3,4], use 'turnover-rate' as a synonym of rate of disappearance. According to this definition, turnover-rate has the dimension: amount/time. Siri[5], on the other hand, uses 'turnover-rate' as the reciprocal of turnover-time. According to his definition, therefore, turnover-rate has the dimension 1/time, that is, it is Zilversmit's rate divided by pool content

Even though it may not have chronological seniority, Siri's terminology is preferable because it is more logical. We may speak of transfer-rate or exchange-rate from one pool to another, or rate of disappearance from one pool, and can say, for example, how many atoms (or grams) of phosphorus are exchanged per unit of time or disappear from a pool per unit of time, and the rate of turnover is the number of times a given pool of, say, phosphorus atoms is turned over, or is renewed, per unit of time As the rate of turnover of a wheel (presumably the original for the analogy) is the linear velocity of the car divided by the circumference of the wheel, so the rate of turnover of a metabolic pool is the transfer-rate divided by the pool content.

If the concentration of tracer changes as a first-order process

$$\frac{d\alpha}{dt} = k\alpha,$$

where α is concentration of tracer (that is, specific activity) and t is time, then k stands for the 'rate constant' in the terminology of chemical kinetics.

If the change in tracer concentration is the result of a transfer process with a constant rate of transfer, a (amount per unit time), from a constant pool content, A, then

$$k = \frac{a}{A},$$

where a/A is the relative rate of transfer. Then,

$$\frac{\text{amount/time}}{\text{amount}} = \frac{1}{\text{time}}.$$

This relative rate of transfer tells what fraction of the pool content, A, is transferred per unit of time or, if a is larger than A, how often the pool content A is turned over per unit of time. This relative rate of transfer is therefore properly called 'turnover-rate' Its reciprocal A/a shows how much time is required for one turnover of a pool of content A This is the 'turnover-time'.

'Renewal-rate' is a synonym of 'turnover-rate', and a similar argument applies for its definition In tracer work we do not study renewal of atoms but of pools, and the renewal-rate should show how many times a pool is renewed per unit of time

It is suggested that for the sake of clarity in terminology, the term 'turnover-rate', or its synonym 'renewal-rate', be used exclusively as an index for the number of times the content of a pool turns over or is renewed, which is the reciprocal of time of turnover

MAX KLEIBER

College of Agriculture,
University of California,
Davis, California
Sept 16

---

[1] Hevesy, G, "Radioactive Indicators", 249 (Interscience Publishers, New York, 1948)

[2] Zilversmit, D B, Entenman, C, and Fishler, M C, *J Gen Physiol*, **26**, 325 (1943)

[3] Feller, D D, Shisover, E H, and Chaikoff, I L, *J Biol Chem*, **187**, 576 (1950)

[4] Searle, G L, and Chaikoff, I L, *Amer J Physiol*, **170**, 456 (1952)

[5] Siri, W, "Isotopic Tracers and Nuclear Radiation", 395 (McGraw-Hill, New York, 1949)

Feulgen-negative Nuclear Division in *Habrobracon* Eggs after Lethal Exposure to X-Rays or Nitrogen Mustard

THE females of the parasitic wasp *Habrobracon juglandis* (Ashmead) when well fed will store eggs in the first meiotic metaphase (metaphase-1) and retain them until the female is placed with the host[1]. The unfertilized eggs develop into viable haploid males. When the untreated egg is oviposited, meiosis proceeds and the pronucleus is formed 30 min after oviposition at 30° C The nuclei divide synchronously at the rate of approximately one division every 15 min At the ninth or tenth cleavage stage (2½–3 hr. after oviposition) most of the nuclei migrate to the egg periphery. After two or three more divisions, cell membranes slowly form between the nuclei, and tissue differentiation begins The embryo hatches about thirty hours after oviposition and feeds on the paralysed host

In the present experiments, well-fed females were treated with X-ray exposures of 10 kr (1 5 kr./min) or an equivalent dose of nitrogen mustard (prophase-1 hatchability was criterion[2]). This exposure is approximately five times the lethal dose for metaphase-1 oocytes The X-rays were delivered by a G. E. Maxitron-250 unit operating at 250 kVp, with a tungsten target and 1 mm. aluminium inherent and 3 mm. of aluminium added filtration (half-value layer, 0 55 mm copper), the nitrogen mustard (kindly supplied by Merck and Co) was delivered in the form of an aerosol. The subsequent development of eggs which were in metaphase-1 during the time of treatment was studied, the eggs were fixed in Kahle's fluid at various times after oviposition and were stained according to the Feulgen procedure after optimum hydrolysis in 1 N hydrochloric acid.

More than 95 per cent of the eggs treated with X-rays and all eggs treated with nitrogen mustard were identical in their developmental pattern. Meiosis proceeds at a normal rate, even when chromosome bridges are present. The first cleavage is partially inhibited, particularly but not specifically at metaphase, for one to two hours after oviposition—nuclear division then slowly proceeds until two to eight Feulgen-positive interphase or prophase nuclei are present, usually near the anterior end of the egg. At approximately the eighth hour after oviposition, ooplasmic areas can be seen within the yolky egg interior. These areas are ordinarily diagnostic for cleavage nuclei, but nothing definite can be recognized within them except for occasional spindle-like structures By the ninth or tenth hour, Feulgen-negative bodies which are otherwise identical with interphase nuclei begin to appear in the ooplasmic areas These become distributed throughout the yolky interior By the tenth or twelfth hour, 50–150 of the Feulgen-negative nuclei have appeared, and they begin to enlarge gradually The two to eight Feulgen-positive nuclei can occasionally be detected at this stage, and they also usually enlarge When nuclear enlargement begins, apparently no more Feulgen-negative nuclei are formed. At twenty hours after oviposition, enlargement of the Feulgen-negative nuclei is nearly maximal (up to 200 times the normal volume) and the Feulgen-positive nuclei are usually not easily detectable

It has been known for several years that, at lethal exposures, both X-rays and nitrogen mustard more or less immediately and specifically interfere with deoxyribonucleic acid synthesis, whereas other intracellular syntheses are not directly disrupted[3] It is probable, therefore, that the strange lethal action of these mutagens on the *Habrobracon* egg is intimately associated with a failure in synthesis of deoxyribonucleic acid. The presence of a few Feulgen-positive nuclei militates against the possibilities that deoxyribonucleic acid is too diffuse to be detected, or that the original pronuclear chromosomes undergo segregation and nuclear division ends with equal and complete distribution of the deoxyribonucleoprotein strands It may be that the characteristics of deoxyribonucleic acid are changed by mutagens so that hydrochloric acid hydrolysis, necessary for removal of purine prior to aldehyde–fuchsin coupling, removes most of, or all, the deoxyribonucleic acid , this hypothesis appears to be contrary to available information[4] Perhaps synthesis of deoxyribonucleic acid has been blocked by nitrogen mustard or X-rays, and the new nuclei are products of other reduplicating systems which are synthesized and replicated until deoxyribonucleic acid is required for further development This proposal must be regarded with considerable caution, since the participation of deoxyribonucleic acid in genetic continuity is a well-established phenomenon[5]

R C VON BORSTEL

Biology Division,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee

[1] Whiting, A R , *Amer Nat* , 79, 193 (1945)

[2] von Borstel, R C , *Genetics* (in the press)

Hevesy, G , "Symposium on Radiobiology", 189 (Wiley, New York, 1952) Bodenstein, D , and Kondritzer, A A , *J Exp Zool* , 107, 109 (1948) Herriott, R M , *J Gen Physiol* , 34, 761 (1951)

Harrington, N J , and Koza, R W , *Biol Bull* , 101, 138 (1951) Moses, M J , DuBow, R , and Sparrow, A H , *J Nat Cancer Inst* , 12, 232 (1951)

[5] Hershey, A D , and Chase, M , *J Gen Physiol* , 36, 39 (1952) Swift, H , "International Review of Cytology", 1 (Academic Press, New York, 1953)

Chromosomes and Nucleoli in *Pisum sativum*

SINCE the beginning of the century, reports have een published in which an ideogram has been given, r at least the morphology of the chromosomes has een described, of *Pisum sativum* With improved echniques and with a better understanding of hromosome structure, it is reasonable to suppose hat recent workers would be in agreement In the atest observations[1], all authors agree that there are ourteen chromosomes in a normal diploid cell , but ere agreement ends There is disagreement over he positions of the centromeres, the number of hromosomes with satellites, and the position of these satellites and their connexion with the nucleoli In addition, a number of secondary constrictions (non-nucleolar) have appeared from time to time in nearly all the chromosomes The majority of these constrictions can, we believe, be traced to the action of the drugs used on the cells prior to fixation The doubts over the relationship of satellites and nucleoli have been prevalent since 1942, when Hakansson and Levan[2] reported that nucleoli are formed at the centromeres of all the chromosomes and that the visible constrictions in the chromosomes are not associated with nucleolus formation

To facilitate the examination of the chromosomes at mitosis, we used monobromonaphthalene and 0 05 per cent colchicine to disorganize the spindle and shorten the chromosomes The use of these drugs is a standard technique and they are not known to produce extra constrictions in the chromosomes La Cour's 2 *BE* proved superior to 2 *BD* or acetic alcohol as a fixative Staining with Feulgen was also superior to either aceto-carmine or aceto-orcein for mitosis Fast green was used as a counter stain to show nucleoli

In the diploid somatic cells, there are usually one or two nucleoli, and occasionally three or four, but never more As corroborative evidence, no more than two nucleoli per nucleus have been observed in the haploid pollen grains Contrary to a previous report[2], we did not find extra nucleolar bodies in the cells at root-tip mitosis, nor did we observe persisting nucleoli at metaphase or anaphase stages of division Two pairs of the chromosomes have nucleolar constrictions and thus have satellites, one pair of satellites being smaller than the other Both pairs are on the long arms of the chromosomes At prophase the attachment of the four chromosomes to the nucleolus, or nucleoli, leaves no doubt that they are definitely associated with nucleolus formation Other secondary constrictions were not observed in any chromosomes In the longest pair of chromosomes the centromere is submedian. There are two short pairs with median or near median centromeres, and one longer pair with a definite subterminal centromere In the remaining pair the centromere is subterminal, but not as markedly as in the nucleolar chromosomes After contraction with drugs, the longest chromosome is only about 4 μ long, and it is therefore difficult and sometimes impossible to pick out all the individual chromosome pairs in a cell Our ideogram (Fig. 1) is therefore presented with a certain amount of reservation In other words, we are unprepared to say that we can distinguish between several chromosomes that are within 0 5 μ of each other in length Our ideogram is substantiated by the sizes and shapes of the chromosomes at second anaphase of meiosis and at mitotic anaphase in pollen grains.

Our squashes of meiotic stages were stained with aceto-carmine and sometimes also with fast green At prophase only one or rarely two nucleoli are formed Frequently they are cap-shaped The prophase division stages are abnormal in that the chromosomes are indistinct and diffuse from after

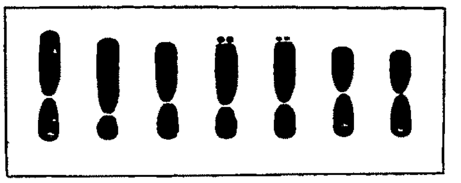


Fig 1 An ideogram of the chromosomes of *Pisum*

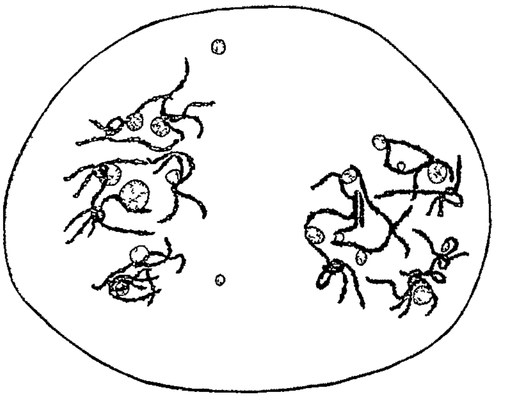


Fig 2 Late prophase of second division of meiosis Note the number and the positions of the nucleolar bodies on the chromosomes × 1,000

pachytene until just prior to first metaphase Along with this condition there is an obvious granular appearance of the nuclear contents. At first telophase a nucleolar-like substance appears interspersed with the chromosomes. During the short resting-stage and the prophase of second division, this substance forms into distinct globules which are associated with the chromosomes (Fig 2) At the same time there are several smaller bodies lying free in the cytoplasm In the nucleus they vary in number from one to twelve There may be one formed on each chromosome, there may be two or three or none What we wish to emphasize is that the bodies arise from the substance that first appears at telophase They are not formed at specific loci of the chromosomes We therefore disagree with Hakansson and Levan, and with Marshak, who reported that the nucleoli were formed at the centromeres of each chromosome. These nucleolar-like bodies disappear at second metaphase and reappear at the following telophase They are present again both inside and outside the nucleus at the tetrad stage They are, however, reduced in number in the nucleus The most we have seen is five

The existence of nucleolar-like bodies or 'telophase globules' is not confined to *Pisum.* We have also seen them in *Zea mays* and in *Phaseolus*, and they have been reported in several species of *Fritillaria*[3]

The nucleolar substance stains like normal nucleoli, the globules appear and disappear at the same stages of division as the nucleoli. They are, in fact, indistinguishable with nucleoli but are not confined to specific loci However, in the root meristems, at prophase of mitosis in pollen grains and probably at prophase of meiosis, the formation of nucleoli is directly associated with specific loci, that is, the nucleolar constrictions. A special system of nucleolus formation may be operative in some species of plants, or may be operative in all species but more obvious cytologically in some

J W. Morrison
Shu-Chang Lin

Cereal Crops Division,
Central Experimental Farm,
Ottawa, Ont.
Sept. 14.

---

[1] Caroli, G, and Blixt, S, *Agric Hort Gen*, 11, 133 (1953) Kihlman, B, *Symb Bot Upsalienses*, 11, IV (1952) Koller, P C, *J Genetics*, 36, 275 (1938) Lewitsky, G A, *Bull Bot Genet Plant Breed Leningrad*, 27 (1931) Marshak, A G, *Cytologia*, 2, 318 (1931)

[2] Håkansson, A, and Levan, A, *Hereditas*, 28, 436 (1942)

[3] Frankel, O H, *Cytologia*, 8, 37 (1937)

Use of the Mouse for Detection of Small Numbers of Tubercle Bacilli

Following early experiments[1], it was considered that the mouse was one of the animals most resistant to tuberculosis More recently, it has been found that the mouse could be readily infected by the intravenous route[2], or by inhalation[3], but it was still considered to be highly resistant to subcutaneous infection. It was found[4] that $C57$ black mice, maintained on a deficient diet and infected intranasally, were as sensitive as the guinea pig for the detection of small numbers of tubercle bacilli. The small lesions produced in the lungs had to be examined microscopically, as non-specific lesions sometimes occurred, in tuberculous lesions there were, of course, numerous bacilli

The mouse is obviously more economical to use than the guinea pig, but the breeding and maintenance of $C57$ mice on a deficient diet and their intranasal inoculation have certain disadvantages for routine work, an attempt was therefore made to develop simpler methods. It is well known that tubercle bacilli multiply freely in the mouse, but sometimes produce very slight lesions Carbon was therefore added to the suspensions of tubercle bacilli so that the position of the inoculum could be seen In preliminary experiments mice were infected by the intravenous, intraperitoneal, intrapulmonary and subcutaneous routes

Carbon was found to be of no special value following intravenous infection, and direct intrapulmonary injection was not regularly successful. Aggregates of carbon were readily found in the omentum following intraperitoneal infection, and sometimes the bronchial lymph nodes contained much carbon, but multiplication of bacilli was not great in these sites The site of inoculation was readily found following subcutaneous (or often intramuscular) infection and, rather surprisingly, it appeared that multiplication of bacilli was abundant and regular, so a more extended series of experiments was performed

Cultures were grown on Loewenstein's medium, weighed when moist, and emulsified in distilled water containing 1 per cent serum. Dilutions were made in this fluid, to which carbon had been added. Each mouse, guinea pig or culture tube was inoculated with 0 1 c.c. of dilution Mice and guinea pigs were killed at intervals and smears made from the small black foci in the subcutaneous or intramuscular tissues and from the regional lymph nodes. Cultures were examined at the same time

Doses of 10^{-4} to 10^{-8} mgm. of human tubercle bacilli were used, and the smallest dose gave negative results in mice, guinea pigs, and on culture tubes Doses of 10^{-7} mgm produced growth on only two or three of four tubes of Loewenstein's medium and produced no lesions in one of four guinea pigs Bacilli were, however, found in all eight mice killed three to six weeks after infection, and in the last mouse small clumps of bacilli were found easily, and there were numerous isolated bacilli. Doses of 10^{-6} mgm produced growth on only two or three of four tubes of Loewenstein's medium, but all guinea pigs became infected Bacilli were readily detected in mice two weeks after infection and were numerous after four weeks Doses of 10^{-4} and 10^{-5} mgm. produced growth on all culture tubes, and bacilli were numerous in mice two weeks after infection. Bovine tubercle bacilli multiplied rather more rapidly than human tubercle bacilli in mice

Myco phlei and four other strains of saprophytic acid-fast bacilli were injected in doses of 10^{-2} to 10^{-4} mgm. With the larger doses, smears from the inoculum revealed many acid-fast bacilli and these were, of course, detected in mice two weeks later After four weeks there were, however, slightly fewer bacilli With doses of 10^{-4} mgm very few bacilli were seen at all, the results were therefore very different from those obtained with virulent tubercle bacilli

In this work three separate laboratory strains of white mice, maintained on stock diets, have all been equally susceptible Mice varying in age from three weeks to 'adult' were used, and although the young mice appeared to be slightly more susceptible, the difference was considered to be unimportant.

No evidence has been obtained to conflict with the view that it is difficult to produce generalized tuberculosis in mice following subcutaneous infection, but the foregoing results indicate that, if smears are made from the site of inoculation, it may be possible to use mice for the routine detection of small numbers of virulent tubercle bacilli. The method is now being tried on clinical material

JOHN FRANCIS

Department of Preventive Medicine,
Veterinary School,
University of Queensland,
Brisbane
Oct 28

---

[1] Cobbett, L, "The Causes of Tuberculosis" (Cambridge, 1917)

[2] Stewart, G T, *Brit J Exp Path*, **31**, 5 (1950) Pierce, C, Dubos, R J, and Schaefer, W B, *J Exp Med*, **97**, 189 (1953)

[3] Glover, R E, *Brit J Exp Path*, **25**, 141 (1944)

[4] Gray, D F, and Mattinson, M W, *Amer Rev Tuberc*, **65**, 572 (1952) Gray, D F, Clarke, B L, and Mattinson, M W, *Amer Rev Tuberc*, **69**, 92 (1954)

Larvæ of *Sphaerophoria* as Predators on Thrips in South Africa

IN an earlier paper[1] attention was directed to the fact that thrips have remarkably few effective natural enemies. Syrphidae were mentioned as predators, but the thrips-feeding habit seems to be very rare in these insects, the larvæ of most of the entomophagous forms feeding on aphids and other Homoptera Some Syrphid larvæ, however, are known to prey on other insects, such as caterpillars, but there seem to be scarcely any records of species feeding on thrips Where thrips are rather inactive and congregated in numbers on leaves or in galls, they would seem to be more liable to attack by predators such as Syrphid larvæ

At Grahamstown, Cape Province, South Africa, larvæ of the Syrphid fly, *Sphaerophoria quadrituberculata* Bezzi (Diptera, Syrphidae), were observed feeding on the immature stages of the thrips, *Cercothrips afer* Priesner, in curled leaves of a plant originally thought to be *Ficus burtt-davyi* Hutch., but now identified as *Ficus craterostoma* Warburg. All the Syrphid larvæ found were in the third or final instar, and were nearly fully grown. They were kept in glass dishes in the laboratory and supplied with thrips several times a day. The thrips larvæ, prepupæ and pupæ were eaten voraciously, the Syrphid larvæ striking out vigorously in all directions until contact was established with the prey, but the adult thrips were not attacked This appears to be the first record in Africa of the thrips-feeding habit in Syrphidae Prof. J. C. Faure, Dr E. K Hartwig and Mr. J C Jacot-Guillarmod kindly inform me (*in litt*, 1954) that they have never observed or know of any records of Syrphid larvæ feeding on thrips in South Africa.

Cercothrips afer is large for a thrips and is a most conspicuous species. The immature stages are bright red, whereas the adults are black and attain a length of 7 mm Although this thrips may occur in considerable numbers in the curled leaves of *F craterostoma*, it lives there as an inquiline, and is not in any way responsible for the curling Actually the curling of the leaves results from the feeding activities of another and smaller thrips, *Gynaikothrips hirsutus* (Karny) This thrips, too, is often very numerous in such curled leaves, which can really be termed open galls, for the inward rolling of the edges of the leaves is accompanied by marked hypertrophy of the plant tissue Both thrips have been recorded previously from South Africa Jacot-Guillarmod[2] found *Cercothrips* associated with *Gynaikothrips* on *Ficus petersii* Warburg in Natal, but, although he suggested the curling of the leaves was probably due to the latter species, he did not state definitely that *Cercothrips* lives as an inquiline in the curled leaves. My observations leave no doubt as to the respective parts played by the two species of thrips

Although the Syrphidae include some of the most important of beneficial insects, they have as yet been little studied in Africa As in other parts of the world, however, the larvæ of the entomophagous species will probably be found to be mainly aphidophagous. The genus *Sphaerophoria* is world-wide in distribution, and its larvæ are known to be predators on aphids and other homopterous insects Only two species of *Sphaerophoria* appear to have been recorded so far from the Ethiopian region *Sphaerophoria quadrituberculata* is a remarkable species It was described by Bezzi[3] in 1915 from Durban, Natal, but does not seem to have been found since. The males are unusual in having a pair of large, conspicuous, raised tubercles on both the third and fourth tergites of the abdomen, to which the specific name directs attention. The structure of the immature stages, described recently by Stuckenberg[4], is equally remarkable, and the thrips-feeding habit of the larvæ is exceptional The feeding habits of this species were hitherto unknown. Curled leaves present a highly specialized environment, and it would be interesting to know if the larvæ of this Syrphid occur in habitats other than galls and prey on insects other than thrips. It seems not unlikely, however, that the larvæ of this species are restricted to this ecological niche in curled leaves and feed exclusively on thrips

I am grateful to Mr C. F. Jacot-Guillarmod for naming the two species of thrips, and to Dr. L. E. W. Codd for the identification of *Ficus craterostoma* Mr. B. R. Stuckenberg kindly identified the Syrphid and described its immature stages, which were previously unknown

E. McC CALLAN

Department of Zoology and Entomology,
Rhodes University,
Grahamstown, South Africa.
Sept 7.

---

[1] Callan, E McC, *Bull Ent Res*, **34**, 313 (1943)

[2] Jacot-Guillarmod, C F, *J Ent Soc S Afr*, **2**, 37 (1939)

[3] Bezzi, M, Brit Mus Pub, **35** (1915)

[4] Stuckenberg, B R, *J Ent Soc S Afr*, **17**, 58 (1954)

Alkaline-Earth Borohydrides and their Applications in Organic Syntheses

WE have pointed out that the alkaline-earth metal borohydrides discovered by us are very suitable for the reduction of ketones and aldehydes to the corresponding alcohols[1] The present communication deals with the application of these borohydrides—particularly of $Ca(BH_4)_2$—for reduction of other functional groups

The most important of these applications is the reduction of carboxylic acid esters to primary alcohols We have been able to reduce a great number of aliphatic and aromatic carboxylic esters, generally in excellent yields, by means of calcium borohydride. For example, we have reduced the following esters to the corresponding carbinols (yields in parentheses) ethyl *p*-nitrobenzoate (96 per cent), ethyl phenylacetate (90 per cent), ethyl glycinate (70 per cent), ethyl alaninate (73 per cent), threo ethyl *p*-nitrophenylserinate (88 per cent), for this last reduction, lithium–aluminium hydride is quite unsuitable[2].

The azlactones, too, proved to be well suited for reduction by the aid of calcium borohydride[3], 2-phenyl-4-benzyliden-oxazol-5-one gave α-benzoylaminocinnamyl alcohol

The above-mentioned reductions can be carried out with solutions of calcium borohydride in hydroxyl-free solvents (tetrahydrofurane), but the alcoholic solutions prepared by the metathesis of sodium borohydride and calcium chloride are equally suitable In alcoholic medium, of course, to avoid the alcoholytic decomposition of the calcium borohydride, the temperature must be kept between about −20° and −10° C (Esters with smaller reactivity are not reducible in alcoholic solution)

It is very interesting that the reductions can also be successfully carried out in solvents of high water content (for example, in 50 per cent alcohol) provided that the temperatures employed are sufficiently low; thus threo ethyl-β-phenylserinate and ethyl *p*-nitrobenzoate are reducible in 50 per cent ethanol with good yields The reductions are generally completed in 4–10 hr.

If required, it is possible to work in a hydroxyl-free solvent by the following technique · the solution of the ester in tetrahydrofurane is stirred for some hours with a mixture of calcium iodide and sodium borohydride at a temperature between 0° and 25° C, or, if necessary, at higher temperature. Obviously the reducing agent is 'nascent' calcium borohydride

We have developed further methods for preparing the alkaline-earth metal borohydrides in solid form For example, calcium borohydride can be obtained from the reaction of anhydrous calcium chloride and sodium borohydride in tetrahydrofurane. The reaction requires 4–8 hr and thorough stirring (with a magnetic stirrer or a ball mill) The solution contains, after the sodium chloride has been centrifuged off, calcium borohydride of fairly good purity. (With such solutions esters with smaller reactivity, such as ethyl benzoate, are also reducible) The solution gives on evaporation *in vacuo* a crystalline tetrahydrofurane addition compound of calcium borohydride

The reducing properties of strontium or barium borohydrides are very similar to those of calcium borohydride

Our experimental results indicate that the calcium borohydride and other alkaline-earth metal borohydrides are reducing agents of higher reducing activity than the other borohydrides hitherto used for reduction purposes, namely, the borohydrides of sodium, potassium and lithium This may be ascribed perhaps to the more covalent character of these compounds

The general opinion, that esters are not reducible with sodium or potassium borohydride[4], must be corrected In our experiments, we succeeded in reducing some esters with sodium and lithium borohydrides in alcoholic solution to primary alcohols in excellent yields Nevertheless, some esters, which are readily reduced by alkaline-earth borohydrides are not reducible by means of lithium or sodium borohydrides under similar conditions

The alkaline-earth metal borohydrides are, in our opinion, among the most important reducing agents. They are suitable for the reduction of esters to primary carbinols, a reaction which is regarded as the most important function of lithium–aluminium hydride In addition, the alkaline-earth borohydrides have a combination of features which is unique · solvents with hydroxyl groups (for example, ethanol, water) may be used, the selectivity of the reductions is greater than in the case of lithium–aluminium hydride, there is no danger of explosion and ignition as contrasted with the latter, compounds sensitive to alkalis can also be reduced, as the solutions of alkaline-earth borohydrides are nearly neutral

We believe that these compounds have good promise *inter alia*, in the study of several groups of natural products, such as the proteins, polypeptides (determination of C-terminal residues[5]), sugar derivatives and polysaccharides

A detailed account of this work will be published elsewhere

J KOLLONITSCH
O FUCHS
V. GÁBOR

Research Institute of the
Pharmaceutical Industry,
Rottenbiller-u 26,
Budapest, VII
Oct 14

---

[1] Kollonitsch, J, Fuchs, O, and Gábor, V, *Nature*, 173, 125 (1954)

[2] Carrara, G, Pace, E, and Cristiani, G, *J Amer Chem Soc*, 74 4949 (1952)

[3] Baltazzi, E, and Robinson, R, *Chem and Indust*, 22, 540 (1953)

[4] Paul, R, and Joseph, N, *Bull Soc Chim France*, 550 (1952) Chaikin S W, and Brown W G, *J Amer Chem Soc*, 71, 122 (1949)

[5] Grassmann, W, Hormann H, and Endres H, *Chem Ber*, 86, 1477 (1953)

Inhibition of the First Limit of the Hydrogen – Oxygen Reaction by Ethane

A STUDY of the inhibiting action of ethane on the second limit of the hydrogen–oxygen reaction in vessels coated with potassium chloride[1] shows that the main features of the inhibition are essentially similar to those reported for propane[2]. The reduction in explosion pressure with increasing mole fraction of ethane is almost exactly linear, and the quantity of inhibitor ($i_{1/2}$) required to halve the explosion pressure is approximately proportional to the mole fraction of oxygen, and approximately independent of the mole fraction of hydrogen, vessel diameter, and vessel surface As in the case of propane, these main facts can be explained by introducing a termination reaction between hydrogen atoms and the hydrocarbon

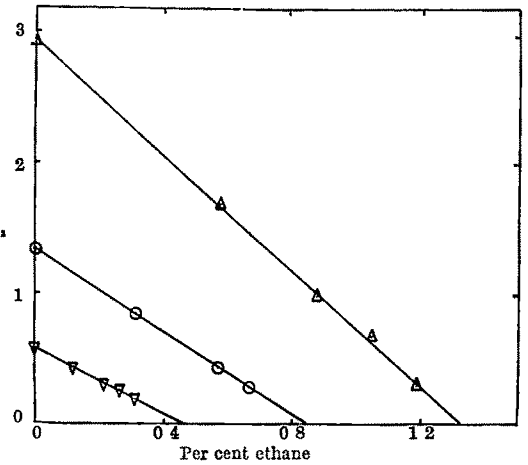


Fig 1 36 mm diameter potassium chloride-coated vessel Temperature 540° C Mole fraction hydrogen, 0 28 Mole fraction oxygen (y) = 0 56 △ , y = 0 28 ○ , y = 0 14 ▽

into the accepted mechanism for the uninhibited second limit[3], when the relation obtained is

$$i_{1/2} = k_1y/k_2, \qquad (\text{i})$$

where y is the mole fraction of oxygen, and k_1, k_2 are the velocity constants of reactions (1) and (2)

$$H + O_2 = OH + O \qquad (1)$$

$$H + C_2H_6 = C_2H_5 + H_2 \qquad (2)$$

This treatment assumes that every radical produced n reaction (2) is destroyed without chain propagation, allowance for this assumption can be made by ntroducing a term Q, the fraction of ethyl radicals destroyed without chain propagation, into the denominator of equation (i) As with propane, second-limit results give no indication of any significant variation of Q with mixture composition, vessel diameter or vessel surface, and the fate of the ethyl radicals thus remains uncertain

In an attempt to examine the fate of the ethyl radicals at low pressures, the inhibition of the first limit by ethane was investigated A simple expression can be obtained if the following assumptions are made (a) only hydrogen atoms are destroyed at he vessel surface, (b) this surface destruction is fficient, and is thus inversely dependent on the pressure ($k_H = A/P$), (c) gas phase termination hrough the termolecular formation of HO_2 is negligible, (d) reaction of oxygen atoms and hydroxyl adicals with ethane can be neglected The expression hen obtained is

$$2k_1y = k_2iQ' + A/P^2, \qquad (\text{ii})$$

where Q' is the fraction of ethyl radicals destroyed without chain propagation at first-limit pressures

Table 1

Hydrogen	Mole fraction Oxygen	Nitrogen	Ratio $I/2i_{1/2} = Q/Q'$
0 28	0 14	0 58	0 87
0 28	0 28	0 44	0 98
0 28	0 56	0 16	0 99
0 44	0 56	—	0 93
0 14	0 56	0 30	0 97
0 10	0 56	0 34	0 98
0 07	0 56	0 37	1 04
0 56	0 14	0 30	0 80
0 14	0 14	0 72	0 87
0 07	0 14	0 79	0 84

Fig 1 shows the linear relation obtained when $1/P^2$ is plotted against i The intercept when $1/P^2 = 0$ is given by $I = 2k_1y/k_2Q'$, and the ratio $I/2i_{1/2}$ thus gives Q/Q'. Table 1 gives this ratio for a wide variety of mixtures, and shows that Q/Q' is effectively constant, and equal to unity Since the first-limit measurements cover the pressure range 5–20 mm mercury, while the second-limit measurements cover the range 50–100 mm. mercury, it may be concluded that over the whole of this pressure-range the fraction of ethyl radicals destroyed is effectively constant

The combination of first- and second-limit results thus suggests that Q is independent of pressure, mixture composition, vessel diameter and vessel surface It is concluded that the ultimate termination reaction is

$$C_2H_5 + O_2 = C_2H_4 + HO_2, \qquad (3)$$

and in consequence, the only possible competing chain propagation reaction can be a reaction with oxygen such as

$$C_2H_5 + O_2 = CH_3CHO + OH, \qquad (4)$$

the fraction Q then being given by

$$Q = k_3/(k_3 + k_4)$$

The high yields (up to 80 per cent) of ethylene obtained in the oxidation of ethane at these temperatures[4], as well as the kinetic facts (Baldwin, R R , and Simmons, R F , unpublished work), require reaction (3) to be at least as fast as reaction (4)

A detailed treatment, in which allowance is made for the assumptions (a)–(d) above, confirms these conclusions, and will be published shortly

R. R Baldwin

Chemistry Department,
University, Hull.

R F Simmons

Royal Aircraft Establishment
Rocket Propulsion Department,
Westcott, Bucks.

---

[1] Baldwin, R R , and Simmons, R F (paper submitted for publication)

[2] Baldwin, R R , Corney, N S , and Precious, R M , *Nature*, **169**, 201 (1952)

[3] Hinshelwood, C N , *Proc Roy Soc* , A, **188**, 1 (1947)

[4] Gray, J A , *J Chem Soc* , 741 (1953)

Photosensitivity of Iron Chelates

During work with iron chelates, it was noted that many chemical analyses for total iron were inconsistent when repeated at intervals on solutions left standing on the laboratory bench in the light. A sensitive method was then devised for the estimation of the chelated iron molecule as a whole, based on the light-absorption of solutions in the ultra-violet region Dilute solutions (approximately 0 0001 M) of the di-sodium iron ethylenediaminetetracetate have an absorption curve with a maximum at about 260 mμ This peak is well separated from, and is much more pronounced than, that of the di-sodium ethylenediaminetetracetate itself at about 210 mμ Therefore, the optical density at 260 mμ, as determined by a spectrophotometer, was used as a measure of the chelated iron present in solutions of the di-sodium iron compound

Solutions of two other iron chelates, namely, those with diethylenetriamminepentacetic acid and with N-hydroxyethylethylenediamminetriacetic acid, can be analysed similarly by determining optical densities at their ultra-violet maxima of about 260 mμ and 245 mμ respectively. It has been noted by using the above method that solutions of these three iron chelates, although they are completely stable in the dark, are decomposed on exposure to daylight, thereby accounting for the inconsistent chemical analyses mentioned above

Other metal chelate solutions tested so far, namely, those of copper and nickel with ethylenediamminetetracetate, are stable in light

The photosensitivity of di-sodium iron ethylenediamminetetracetate has been noted previously by Jones and Long[1] , but this important point seems to have been overlooked by biologists The proposed scheme for this decomposition, as published[1], is

(i) Ferric-EDTA + light $\longrightarrow$ Ferrous-EDTA + decomposition products of EDTA

(ii) Ferrous-EDTA + $\frac{1}{2}$ H_2O + $\frac{1}{4}$ O_2 $\longrightarrow$ Ferric-EDTA + OH'

(iii) By repeated photoreduction and subsequent re-oxidation, sufficient hydroxyl ions are released to form the hydroxy-compound, Fe(OH)EDTA, and finally to precipitate ferric hydroxide

Results I have obtained with the ultra-violet absorption method on solutions of di-sodium iron ethylenediamminetetracetate exposed to light are in accord with the above scheme, except that no decomposition of the ethylenediamminetetracetate molecule has been recorded. It is therefore of prime importance in quantitative laboratory experiments that solutions of these iron chelates should be protected from the action of light

Another practical point is that vessels in which solutions of iron chelates have been decomposed by light acquire a tenacious deposit of iron hydroxide This deposit is best removed by an acid rinse, being little affected by the normal wash with water and detergent

The three iron chelates mentioned above have been used as a source of iron for plants[2,3] Their mode of action is not understood, but it is thought that plants absorb through their roots the whole chelate molecule and translocate it intact[4] There is, however, no evidence to show how plants obtain the iron from this very stable complex (log K of the ferric compound = 25 1 [5]) It has been postulated that the iron is only released after the ethylenediamminetetracetate has been partially metabolized[6] , alternatively, a more stable complex would have to be formed

In view of the photosensitivity of iron chelates a further possibility arises, namely, that reduction takes place within the plant leaves, to give the less-stable ferrous compound (log K = 14 2 [5]) Then the iron in this form could be removed more readily by complex-formation with proteins or could be replaced by some other metal ions, for example, copper and zinc

Further experiments are in progress to test the significance of the photosensitivity of iron chelates in plant nutrition and these will be reported later

D G HILL-COTTINGHAM

Long Ashton Research Station,
University of Bristol
Nov. 1.

[1] Jones, S S , and Long, F A , *J Phys Chem* , 56, 25 (1952)

[2] Jacobson, L , *Plant Physiol* , 26, 411 (1951)

[3] Wallace, A , North, C P , Kofranek, A M , and Lunt, O R , *Calif Agric* , 13 (Oct 1953)

[4] Wallace, A , and North, C P , *Calif Agric* , 10 (Aug 1953) Leonard, C D and Stewart, I , *Proc Amer Soc Hort Sci* , 62, 103 (1953) Weinstein, L H , Purvis, E R , Meiss A N , and Uhler, R L , *J Agric and Food Chem* , 2, 421 (1954)

[5] Schwarzenbach, G , and Heller, J , *Helv Chim Acta*, 34, 576 (1951)

[6] Weinstein, L H , Robbins, W R , and Perkins, H F , *Science*, 120, 41 (1954)

Deposit of Spheroidal Graphite

THE superior mechanical properties of nodular cast iron, in comparison with other cast iron, are believed to be due to the graphite which is present in a spheroidal form. Small additions of various metals, and suitable heat treatment, induce or inhibit the formation of this variety of graphite, and recently the presence of hydrogen in the gas atmosphere has been demonstrated to have a marked influence[1]. No generally accepted explanation of this phenomenon has been advanced , but several investigators have suggested that the presence of foreign particles is necessary in order to induce nucleation or growth of the spherulites by an epitaxis or by screw dislocation mechanism[2]

During experiments whereby small samples of refractory materials were heated in a wire-wound mullite tube furnace in a moisture-free town's-gas atmosphere at temperatures varying from 1,100° to 1,600° C , the samples were found to be coated with

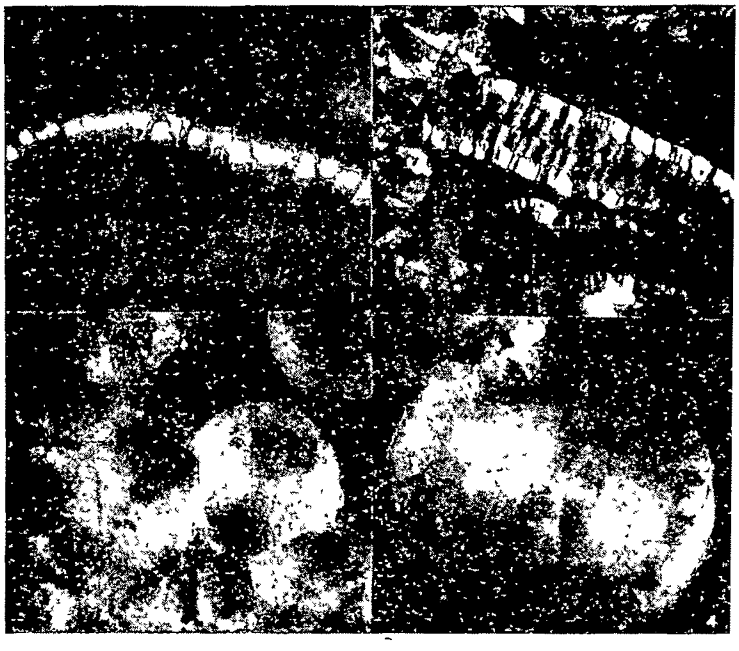


Fig 1 Typical filament × 315

Fig 2 Longitudinal section of a filament × 350 (reflected light, crossed nicols)

Fig 3 Cross-section of botryoidal structure × 720 (polarized light)

Fig 4 Cross-section of individual sphere × 720 (polarized light)

a deposit of graphite which was composed entirely of spheroids in botryoidal and filamentous aggregates. Microscopic examination revealed that the filaments were composed of a string of spheres or sections of spheres, remarkably similar to the spherulites in the nodular cast iron[3].

Fig. 1 shows a typical filament and Fig. 2 shows a longitudinal section. Figs. 3 and 4 are cross-sections of a botryoidal structure and of an individual spheroidal structure respectively. On the surface of many of the spheres, spiral structures were observed and photographed. These were particularly abundant in the botryoidal masses.

X-ray examination gave a pattern of graphite.

We are grateful to the Ministry of Supply, and to Dr. A. T. Green, director of the British Ceramic Research Association, for permission to publish this communication.

B. VASSILIOU
E. W. ROBERTS
G. R. RIGBY

British Ceramic Research Association,
Queens Road,
Penkhull, Stoke-on-Trent.
Oct. 15.

---

[1] Hultgren, A., and Östberg, G., *J. Iron and Steel Inst.*, 351 (1954).

[2] Hilbert, M., and Lindblom, Y., *J. Iron and Steel Inst.*, 388 (1954).

[3] Morrogh, H., *J. Iron and Steel Inst.*, 378 (1954).

Geological Ages of Witwatersrand Uraninites

THE origin of the gold and the uranium in the conglomerates of the Witwatersrand system is a much-disputed problem. Two main schools of thought seem to have emerged, namely, the adherents to a placer hypothesis and those who support a hydrothermal theory of origin. Geological age determinations on Witwatersrand uraninites would yield valuable information to geologists concerned with this problem, since it is universally agreed that this system is of sedimentary origin and a maximum possible age for the system as a whole can be arrived at from field observations.

Davidson[1] undertook an age study on a sample of Witwatersrand uraninite by the lead-isotope method and obtained age values which at first could not satisfy the requirements of a hydrothermal theory of origin unless the Witwatersrand system was about twice as old as geologists were willing to believe, and thus considerably older than any other known sedimentary system. Subsequent geological age determinations on this same sample were made by J. L. Kulp[2,3] and Collins, Farquhar and Russell[4]. Further views on these results by Davidson[5] tend to reconcile the calculated most probable age with a hydrothermal theory of origin, which required a uraninite age younger than the possible maximum age of the sedimentary system. Geologists possessing an intimate knowledge of the Witwatersrand put the maximum possible age of this system at about 1,000 million years, whereas the age calculations of Davidson have successively decreased the most probable age from about 1,700 million years to between 465 and 816 million years. These figures were arrived at without undertaking a further study of more uraninite samples from this system.

The Witwatersrand system, in the type area, is some 25,000 ft. thick and its horizontal extent stretches over a 'strike' of about 150 miles. For this reason, no far-reaching conclusions should be drawn from the results of the study of a single, isolated sample of uraninite concentrate.

I have completed age analyses on ten samples of uraninite concentrates, three 'carbon' (thucholite) concentrates and two samples of uranium-rich 'carbon' ores according to the lead-isotope method, in conjunction with which four galena samples were analysed for their lead isotopic patterns. The samples were chosen to represent almost all the different recognized series of the system, and in horizontal extent the entire existing mining area was covered. A study of the patterns of apparent ages calculated from the RaG/UI, AcD/AcU and the AcD/RaG relations indicated that in most cases a loss of radon of between 5 and 27 per cent should have occurred while in other cases the discrepancies in apparent ages of a particular sample could be explained by assuming a loss of uranium, or a loss of lead, or additions of old radiogenic lead, sometimes in addition to loss of radon. These conclusions were drawn after the manner of Holmes[6]. It is thus clear that the Witwatersrand uraninites are, strictly speaking, unsuitable material for accurate age determinations.

Nevertheless, a study of the apparent ages and radiogenic lead-isotope patterns found for the suite of samples as a group indicates that all the uraninites of the Witwatersrand system proper probably have the same geochemical and mineralogical history. The results seem to justify the conclusion that all these uraninites have a true age of between 1,850 and 1,950 million years, and that this mineral was therefore introduced into the Witwatersrand sedimentary beds as a detritus, being derived by an erosion process from an ancient source. Evidence of some form of reworking in the sedimentary system, after its deposition and consolidation, is proved by the admixture of radiogenic lead found in a galena which occurred as isolated large and perfect crystals and by the signs

Table 1

Sample	Pb^{204}/Pb^{206} (per cent)	Estimated radiogenic Pb (per cent)	AcD/RaG (per cent)	t_{UI}	t_{AcU}	$t_{\frac{AcD}{RaG}}$	Preferred age (Figures in brackets doubtful)
Black Reef 'carbon'	1.03	59.9	15.74	2,014	2,254	2,460	(2,000–2,400)
Western Reefs uraninite	0.198	89.7	13.38	1,391	1,727	2,180	(1,730–2,180)
Western Reefs 'carbon'	0.333	83.7	14.98	1,668	1,997	2,375	(2,000)
Marievale uraninite	0.60	73.6	12.27	1,304	1,595	2,035	(2,035)
Marievale 'carbon'	0.73	68.0	12.41	2,199	2,121	2,050	(2,050)
Freddies uraninite	0.45	68.3	12.02	1,128	1,456	2,000	(2,000)
Wit Nigel uraninite	0.18	86.7	11.50	1,182	1,443	1,900	(1,900)
Sub Nigel uraninite (*a*)	0.08	94.1	13.79	1,612	1,875	2,215	1,875
Sub Nigel uraninite (*b*)	0.14	89.2	13.75	1,566	1,864	2,230	1,864
Blijvooruitzicht uraninite	0	100	12.29	1,825	1,913	2,020	1,913
Blijvooruitzicht 'carbon'	0.075	95.5	12.48	2,101	2,072	2,060	(2,000–2,100)
Babrasco 'carbon'	0.40	79.2	13.50	1,782	1,973	2,195	(1973)

of loss of uranium from some uraninites found in 'carbon'

Uraninite from the Black Reef, which is composed of the erosion products of the Witwatersrand system, indicated a loss of uranium, which implied that the mineral was unable completely to survive this secondary erosion process. The survival of the original uraninites during their alluvial transportation period may, however, be explained if it is postulated that the earth's atmosphere at the time of the deposition of the Witwatersrand system was of a reducing (or at least a neutral) nature (with all the geochemical implications of such a postulate) as opposed to the oxidizing nature of the present atmosphere. According to Urey[7], the postulated transition could have occurred not much later than about 800 million years ago

Some of the most pertinent data obtained in this study are given in Table 1, where the samples are arranged in stratigraphical order and ages are given in millions of years

A full account of this work and a more complete discussion of the reliability of the results and their implications will be published in the forthcoming issue of the *Transactions of the Geological Society of South Africa*, 57

I wish to acknowledge the services of the analytical chemist, Mr. F. W E. Strelow, of the South African National Chemical Research Laboratory, and the assistance of Drs L T. Nel, B Wasserstein, D J Simpson, W. R. Liebenberg and R A Pelletier in valuable discussions and the supply and mineralogical processing of samples

This note is published by permission of the South African Council for Scientific and Industrial Research

J D Louw

National Physical Laboratory,
South African Council for
Scientific and Industrial Research,
Pretoria
Oct 12

---

[1] Davidson, C F, *Mining Mag*, 3-15 (1953)
[2] Kulp, J L, U S A E C Report NYO 6,200 (1953)
[3] Kulp, J L, U S A E C Report NYO 6,198 (1953)
[4] Collins, Farquhar and Russell, *Bull Geol Soc Amer*, 65, 1 (1954)
[5] Davidson, C F, *Bull Inst Min Metall*, 63, 244 (1954)
[6] Holmes, A, *Trans Edin Geol Soc*, 14, Part II (1948)
[7] Urey, H C, "The Planets—Their Origin and Development" (Yale University Press, 1952)

Proposal for a New Æther Drift Experiment

Furth[1] has recently suggested a repetition of the Michelson–Morley experiment using microwaves and attempting to detect the change in resonant frequency of a cavity as it is rotated through 90° Essen[2] proposes that any change in the resonant frequency of the cavity be detected by using the cavity to control an oscillator the frequency of which is compared with that of a quartz standard, and estimates that a change in resonant frequency of one part in 10^{10} might be detectable

If instead of the cavity being used to control the oscillator frequency, as in Essen's method, it is used to produce a phase change in a signal from a fixed-frequency oscillator, greater sensitivity can be obtained

The method is demonstrated in principle in Fig 1 The output of an oscillator operating at the resonant frequency of the cavity is split into two branches, one of which contains the rotating cavity the other a broad-band 90° phase-shifter Thes two branches feed a phase-sensitive detector followe by a tuned amplifier and output indicator Th auxiliary feedback circuit shown in dotted line maintains the oscillator at the mean resonant fre quency of the cavity As will be shown later, th refinement may not be necessary

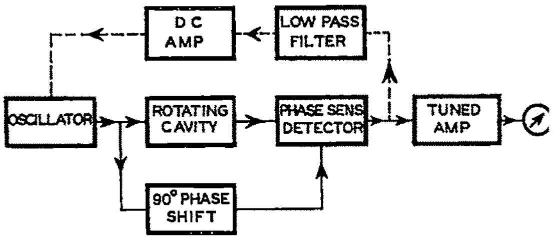


Fig 1

Let a rotation of the cavity through 90° produce change Δf in the resonant frequency of the cavity which is assumed to be resonant initially at th oscillator frequency f. Then the change in phas $\Delta\varphi$ on passing through the cavity will be $\Delta\varphi =$ $2Q \ \Delta f/f$, Q being the quality factor of the cavity Thus, since we are dealing with very small values $\Delta\varphi$, the detector output amplitude will vary a $\cos(\pi/2 + \Delta\varphi) \approx -(\Delta\varphi)$

If the cavity is rotated continuously, then an effects due to æther drift will appear twice eac revolution. Thus if the amplifier is tuned to twic the rotation frequency and has a narrow band-widt changes due to random drifts in frequency and t vibration, at other than twice the rotation frequenc will be eliminated A suitable means of obtaining narrow band-width would be the use of a synchronou rectifier switched at twice the rotation frequency followed by a low-pass filter

An estimate of the minimum detectable change frequency $\Delta f/f$ may be made as follows. If th resonator output power is P_r, then the output the detector will be $P \propto P_r(\Delta\varphi)^2$ Assuming th detector and amplifier have a noise factor N and ban width B, and that the minimum detectable power equal to the noise power, the minimum detectabl value of $\Delta f/f$ is

$$\frac{1}{2Q}\sqrt{\frac{NkTB}{P_r}}\,, \qquad (1$$

where k is Boltzmann's constant and T the absolut temperature As an example, consider a 10,000 Mc / cavity of $Q = 10^4$, an input power to the detecto $P_r = 10^{-3}$ W., a noise factor $N = 20$, a band-widt $B = 1$ c/s, and temperature $T = 300°$ K. The the minimum detectable value of $\Delta f/f$ is 5×10^{-1} an improvement of 200 times on the method suggeste by Essen. The value of N used here is appropriat to a superheterodyne system based on Fig 1. Fo simplicity the frequency-changing stages have bee omitted from Fig 1 In principle, the sensitivit can be increased without limit by reducing th amplifier band-width B

The basic advantage of the method suggested her over those which involve a measurement of fre quency-differenc is that it is a phase-differenc between signals from the same source which measured Thus the stability of the source is no particularly important, provided that its frequenc remains within a region less than f/Q If the inpu signal is such that a phase difference of φ occurs the cavity, and rotation of the cavity produces a further periodic phase change $\Delta\varphi$, then the detector output power is proportional to $[\sin(\varphi + \Delta\varphi) - \sin\varphi]^2 = [\cos\varphi \sin\Delta\varphi]^2$. Hence, when $\varphi < \pi/4$, the reduction in sensitivity is small. Because $\Delta\varphi$ is periodic, it will be amplified, whereas accidental changes in phase-angle uncorrelated with $\Delta\varphi$ will be suppressed.

While not strictly relevant to Furth's suggestion, it is worth noting that the method suggested here is applicable to experiments such as those of Wood, Tomlinson and Essen[3], if the cavity is replaced by a quartz resonator. This should result in a considerable increase in sensitivity because of (*a*) the higher Q obtainable, (*b*) the ability to apply larger powers to the detector, and (*c*) the lower noise figures realizable at lower frequencies. As an example, consider a quartz resonator with frequency 100 kc./s. having $Q = 2 \times 10^5$, $P_r = 10$ mW., and $N = 2$, other parameters being as before. The minimum detectable $\Delta f/f$ is approximately $2·5 \times 10^{-15}$.

D. D. CROMBIE

Dominion Physical Laboratory
(Dept. of Scientific and Industrial Research),
Lower Hutt,
New Zealand.
Oct. 14.

[1] Littman Furth, H., *Nature*, 173, 80 (1954).

[2] Essen, L., *Nature*, 173, 734 (1954).

[3] Wood, A. B., Tomlinson, G. A., and Essen, L., *Proc. Roy. Soc.*, A, 158, 606 (1937).

Use of Soluble Filter Gauzes

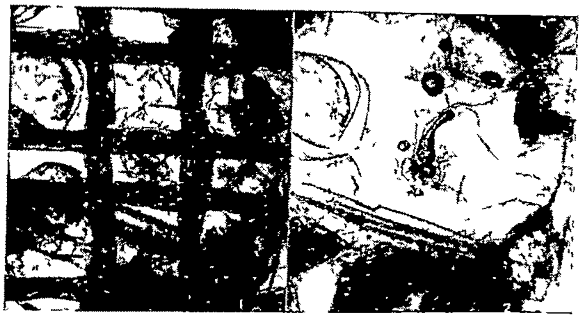
IN connexion with filtration problems in agricultural spraying machinery, we have been making a study of the nature and quantity of matter in natural waters capable of being retained on filter gauzes. We found it necessary to develop a technique for this purpose which we think may be of interest in biological investigations.

Removal of the material from the gauze for microscopic examination is not satisfactory, as it cannot be assumed that a fair sample is removed or that delicate structures are not damaged. We therefore replaced the metal gauze by one of cellulose acetate, with the intention of dissolving away the filter base after transfer to a microscope slide. The filtered matter, mainly mineral and cellulose structures, could be left *in situ* undissolved and clearly visible.

To simulate 100-mesh wire gauze, an acetate fabric was kindly supplied by Messrs. Courtaulds consisting of 45-denier 10-filament (continuous) yarn with 30 turns to the inch woven with 92 warps and 84 wefts per inch.

400 ml. of water was found to give a convenient amount of deposit on a $B14$ cone (area $= 0·44$ sq. cm.). The part of the mesh containing the deposit was carefully cut out and mounted on a microscope slide. The presence of water on the yarn as well as in the organic matter gave rise to a cloudiness on dissolving the acetate mesh directly in acetone. It was therefore found necessary to dehydrate the specimen by successive washes in 30, 70 and 100 per cent ethanol before applying the acetone. The alcohol and acetone were introduced at the edge of the specimen and allowed to flow across by holding the slide obliquely. A cover slip was placed over the esidue before the acetone had evaporated.

Figs. 1 and 2 are photographs of the same deposit taken before and after dissolving the filter. These illustrate the greater detail visible when the filter is removed, both as regards absence of the fibres of fabric and also because of the greater ease with which the image can be focused. There is little disturbance of the disposition of the residue in the process except for some shrinkage in the diameter of filamentous matter and slight movement due to surface tension effects.



The colour of algae is sufficiently well retained during the solvent treatment to enable them to be clearly distinguished from colourless structures.

Thanks are due to Dr. G. S. Hartley for suggesting this method, and to the Board of Pest Control, Ltd., for permission to publish this work.

M. A. NAUGHTON
J. M. SWINSTEAD

Chesterford Park Research Station,
Nr. Saffron Walden, Essex.
Nov. 1.

Method for Recovery of Metallic Grids for Electron Microscopy

THE metallic grids used as supports for the parlodion films containing material for electron microscopy are usually rejected after use. Good results in recovering these grids were obtained by the use of the following technique, which is a modification of one previously described[1].

Initially, the grids are washed with hot distilled water to dissolve soluble salts. The film of oil from the diffusion pump is removed by boiling the grids in a 0·1 per cent soap or any detergent solution for half to one hour and leaving them to stand in contact with the soap solution for a day at room temperature. The soap is then removed by washing with hot distilled water, followed by another washing with acetone to ensure complete removal of any residual oil. After treatment with acetone, the grids are placed in contact with approximately 1 N hydrochloric acid solution at 30–40° C. to remove the products of corrosion of the grids. The time of contact with the acid solution depends on the metal (less for copper and more for nickel grids) and also on the degree of corrosion. Generally, after no more than ten or twenty minutes, all grids present a clear bright surface and the acid solution can be poured off. The clean grids are then carefully washed with boiling distilled water to remove all traces of acid and dried at 100–120° C. protected from dust. The cleanliness of the grids can be checked by optical or electron microscopical examination, but it is not necessary. It was found that a small can, open on the top and having about twenty holes drilled in the bottom, is very convenient for washing the grids with water and acetone. Generally, ten washings were sufficient to ensure complete removal of the cleaning solutions

The more dilute solutions of soap and especially of hydrochloric acid give better results than concentrated ones, as described before[1], because no close control of the time of contact between the grids and the cleaning solutions was necessary.

This method of cleaning used grids has some advantages over the flambage cleaning method proposed by Eaves[2], because it does not make them friable nor does it destroy copper grids, as pointed out by Eaves, however, it does involve much more material and time

PERSIO DE SOUZA SANTOS

Laboratorio de Virus,
Instituto Butantan,
São Paulo, Brazil
Oct 12

[1] Souza Santos, P de, *Ciencia e Cultura (Sao Paulo)*, 4, 46 (1952)

[2] Eaves, G, *Nature*, 169, 975 (1952)

Use of Methyl Cellulose Gel as a Substitute for Agar in Tissue-Culture Overlays

IN the course of experiments designed to assay non-cytopathogenic animal viruses by Dulbecco's plaque-count method[1] using fluorescent antibody[2] to identify the plaques, a non-fluorescent substitute was required for the agar used in the overlay Methyl cellulose has been used by Earle[3] to increase the viscosity of tissue-culture fluids for suspended-cell cultures, and appears to be harmless to animal tissue. An investigation of its properties showed it to be capable of forming highly viscous aqueous solutions which would gel spontaneously on raising their temperature The presence of salts at physiological concentrations lowers the temperature of gelation Thus one can make a solution of methyl cellulose containing tissue nutrients which, after being added as a liquid at room temperature to the tissue, will set quite firmly soon after being placed in an incubator at 37° C. A further advantage is that this overlay can be removed entirely without disturbing the tissue, this is achieved by cooling the culture in a refrigerator for a short time, during which the gel liquefies, enabling it to be removed by pipetting

The following procedure was used for obtaining 'bare' plaques of fowl-plague virus entirely free from overlay. Petri-dish tissue cultures of chick tissue monolayers were made by Dulbecco's method[1], and infected, 5 ml of 1·5 per cent methyl cellulose overlay was poured on to each infected plate and incubation continued for a further three days The overlay was prepared as follows 1·5 gm methyl cellulose of 4,000 centipoises viscosity (Dow Chemical Co) (previously thoroughly washed with alcohol and ether) was added to 15 ml. de-ionized distilled water at 100° C in a 250-ml conical flask The flask was shaken to disperse the methyl cellulose (which is insoluble at this temperature) and immediately autoclaved After removal (still hot) from the autoclave, a warm sterile mixture of 5 ml four-fold Earle's saline[4] and 80 ml synthetic medium (Waymouth, C, personal communication) containing antibiotics was added and thoroughly mixed On cooling rapidly with agitation, the methyl cellulose dissolved to give a clear viscous solution This was stored frozen at – 20° C.

Following incubation of Petri-dish cultures, the overlay was pipetted off after adding 10 ml. of phosphate-buffered saline at 0° C. to each plate, and chilling for $\frac{1}{2}$ hr. The cultures were rinsed with more phosphate saline and were then available for staining for 10 min with vital stain, or other treatment

Under this overlay, plaques due to fowl plague virus take three days to become visible, whereas under agar only two days are required. This is believed to be due to a lower rate of diffusion of the virus in the methyl cellulose overlay, tests have indicated that the latter has no inhibitory or inactivating effect upon this virus.

Advantages of methyl cellulose overlay over agar are (1) non-fluorescence, (2) simpler handling after a stock is made up, (3) overlay can be completely removed, (4) complete absence of toxicity on cells

Disadvantages of the method are (1) plaques take longer to form, (2) stock solutions are more difficult to prepare, (3) gel is much weaker than that obtained with agar of equivalent concentration.

A few experiments have been made with methyl cellulose gel for other uses in tissue culture It may be used as a substitute for plasma clot, but seems inferior to the latter as judged by the rate of increase in size of outgrowths from explants. Tests indicate that such gels have useful applications in bacteriology, these are under investigation.

J. E. HOTCHIN

Medical Research Council
Common Cold Research Unit,
Harvard Hospital,
Salisbury
Oct 7.

[1] Dulbecco, R, *Proc U S Nat Acad Sci*, 38, 747 (1952)

[2] Coons, A H, and Kaplan, M H, *J Exp Med*, 91, 1 (1950)

[3] Earle, W R, Schilling, E L, Bryant, J C, and Evans, V J, *J Nat. Can Inst*, 14, 1159 (1954)

[4] Earle, W R, *J Nat Can Inst*, 4, 165 (1943)

Preservation of Dogfish

IN institutions where dogfish are used for dissection, the preservative most commonly employed is a solution of formaldehyde in water. Formaldehyde is a good preservative, but its volatile and pungent character makes its use in the class-room and the store-room a matter of disagreeable compulsion

Experiments first started in 1939 to find a suitable storage fluid to replace formaldehyde showed that pine oil compounds possessed many advantages in checking the growth of bacteria and fungi 'Perminal KB' is a pine oil emulsion produced by Imperial Chemical Industries, Ltd, to assist in the kier boiling of cotton—as a solvent for fats and waxes, and as an emulsifying agent. When diluted with water it is an excellent preserving fluid for dogfish which have been fixed in formaldehyde The steps are as follows: (1) wash the fixed dogfish in water overnight to remove the formaldehyde, (2) place in 'Perminal KB' 10 c c, water 90 c.c, rinse the specimens under the tap before dissection

Dogfish so treated have been kept in this solution for more than five years without evidence of deterioration, but it should be emphasized that this method is of use only with fixed material Fresh, unfixed material placed in this solution will decompose

H F. STEEDMAN

Zoology Department,
University, Glasgow, W.2.
Nov. 1.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 21

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 5 p m—Mr A A L Caesar "Economic Planning of Eastern Europe"

British Society for the History of Science (in the Lecture Theatre of the Science Museum, South Kensington, London, S W 7), at 5 30 p m—Mrs J M Eyles "Thomas Charles Hope and his Geological Lectures"

Institute of Petroleum (at 26 Portland Place, London, W 1), at 5 30 p m—Mr P Leicester "The Modern Planning of Regional Surveys for Petroleum"

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W C 2), at 5 30 p m—Commander C G Forsberg, R N, and Mr G G MacNeice Informal lecture on "The Recent Search for and Salvage of the Comet Aircraft near Elba"

Society of Chemical Industry, Pesticides Group (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m—Meeting on "Vacuum Fumigation" Mr W Burns-Brown "Physico-Chemical Effects", Mr A B P Page "Biological Effects"

University of London (at King's College, Strand, London, W C 2), at 5 30 p m—Dr James Henderson "From Sixth Form to University—Problems and Dilemmas" * (From a series of lectures on "Looking Forward in Education")

Society of Chemical Industry, London Section (at the Royal Institution, 21 Albemarle Street, London, W 1), at 6 p m—Dr James Taylor "The Progressing of New Projects from the Laboratory to the Plant" (Jubilee Memorial Lecture)

Tuesday, February 22

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 2), at 1 15 p m—Dr. R P Kelvin "Missing the Point in Psychology" *

Institution of Civil Engineers (at Great George Street, Westminster, London, S W 1), at 5 30 p m—Mr A M Muir Wood "Folkestone Warren Landslips—1948–1950 Investigations", Mr N E V Viner-Brady "Folkestone Warren Landslips—Remedial Measures, 1948–54"

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m—Prof A C Frazer "Fat Metabolism" * (From a series of lectures on "The Scientific Basis of Medicine")

University of London (in the Geology Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S W 7), at 5 30 p m—Prof L U de Sitter (Leiden) "Strain of Rock as determined in the Laboratory" * (First of three lectures on "The Strain of Rock in Mountain-Building Processes" Further lectures on February 25 and 28)

Aslib (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W C 2), at 6 p m—Mr Jack Bird "A New Look at Library Literature, or Why Write about Information Work ?"

Society for Analytical Chemistry, Midlands Section (at the University, Edmund Street, Birmingham 3), at 7 15 p m—Inaugural Meeting Dr D W Kent-Jones "Developments in the Society for Analytical Chemistry"

Wednesday, February 23

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m—Mr F C Bawden, F R S "Virus Diseases of Plants" (Fernhurst Lecture)

Physical Society, Colour Group (at the Institute of Ophthalmology, Judd Street, London, W C 1), at 3 30 p m—Mr T H Vinnicombe "The Robbialac Colorizer Method of Paint-Colour Mixing and its Value to All Concerned in the Usage of Colour"

Geological Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m—Mr R G West and Mr J J Donner "The Glaciations of East Anglia and the East Midlands, a differentiation based on Stone Orientation Measurements of the Tills"

Royal Society of Medicine, Endocrinology Section (at 1 Wimpole Street, London, W 1), at 5 p m—Discussion on "Hormones and Cancer" Opening Speakers Sir Stanford Cade and Sir Charles Dodds

Institution of Electrical Engineers, Supply Section (at Savoy Place, London, W C 2), at 5 30 p m—Mr Å Rusck "High-Voltage Transmission Developments in Sweden"

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 6 30 p m—Mr R K Vinycomb "A Versatile Electronic Engine Indicator"

Society of Chemical Industry (joint meeting of the Food and Microbiology Groups, in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m—Mr D H F Clayson "Food Perishability in Terms of Micro-ecology"

Royal Institute of Chemistry (at Norwood Technical College, Knights Hill, West Norwood) at 7 p m—Dr Tudor S G Jones: "Chromatography Theory and Some Applications"

Thursday, February 24

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m—Prof Wilson Smith, F R S, Mr G Belyavin and Mr F W Sheffield "The Host Tissue Component of Influenza Viruses", Mr R Halliday "The Absorption of Antibodies from Immune Sera by the Gut of a Young Rat"

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m—Prof A G Walker "Tangent Planes"

Institute of Refrigeration (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S W 1), at 5 30 p m—Mr G Yate Pitts "Sub-soil Temperatures and Frost-heave"

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m—Dr R A Kekwick, "The Plasma Proteins" * (From a series of lectures on "The Scientific Basis of Medicine")

Friday, February 25

Association of Applied Biologists (at Imperial College, Imperial Institute Road, London, S W 7), at 10 45 a m—Scientific Papers

Royal Meteorological Society (joint meeting with the Royal Astronomical Society, at Burlington House, Piccadilly, London, W 1), at 2 30 p m Discussion on "Hydrodynamical Processes in Meteorology and Geophysics"

Physical Society (in the Lecture Theatre, Science Museum, South Kensington, London, S W 7), at 5 p m—Dr W S Stiles "The Basic Data of Colour-Matching and some related Aspects of Visual Theory" (Thomas Young Oration)

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m—Dr Eric Ashby "A Procession of Flowers"

Saturday, February 26

Association of Scientific Workers (in co-operation with the Education Committee of the London Co-operative Society, at the Central Hall, Westminster, London, S W 1), at 2 30 p m—Prof C H. Powell, F R S "The H-bomb"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Senior Biologist in the Chief Engineer's Department, British Electricity Authority, to take charge of a small biological laboratory situated in North London and undertake research and advise the Authority on the effects of power station operation upon the life of rivers and other waterways—Director of Establishments, British Electricity Authority, Winsley Street, London, W 1, quoting AE/568 (February 25)

Scientific Officer (with a first- or second-class honours degree in engineering or equivalent qualification, and workshop training or apprenticeship) in the Department of Scientific and Industrial Research, Low Temperature Research Station, Cambridge (after one year's training at Torry Research Station, Aberdeen) for research in refrigeration, processing and handling of meat—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting C 43/5A (February 26)

Lecturer in Applied Mathematics—The Registrar, King's College, Newcastle-upon-Tyne (February 28)

Lecturer (with a university degree in physical chemistry or chemical engineering) in Chemical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (February 28)

River Inspector (corporate member of the Royal Institute of Chemistry and of the Institute of Sewage Purification, or other appropriate qualifications)—The Clerk, Lothians River Purification Board, City Chambers, High Street, Edinburgh (February 28)

I C I Research Fellows in Physics, Chemistry, Engineering, Metallurgy and Pharmacology, or any related subject, and Leverhulme Postgraduate Fellows (2) in the Faculty of Science—The Registrar, The University, Liverpool (March 1)

Reader in Experimental Physics at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W C 1 (March 3)

Senior Scientific Officer (with a degree in physics or engineering, and experience in the design and development of lenses, and the supervision of a small optical workshop) in the Department of Supply, Weapons Research Establishment, Salisbury, South Australia, to undertake the design and development of optical systems for special purpose cameras and optical instruments—The Senior Representative, (A P 27), Department of Supply, Australia House, Strand, London, W C 2 (March 3)

Lecturer in Anglo-Saxon Antiquities and Archæology—The Secretary, University of Durham, 38 North Bailey, Durham (March 5)

Chair of Applied Science, with special reference to engineering, tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W C 1 (March 7)

Ciba Fellow in Clinical Pharmacology, to develop techniques for the clinical evaluation of drugs where suitable techniques are not already available—The Secretary of University Court, The University, Glasgow (March 12)

Lecturer in Chemistry (Organic Chemistry)—The Secretary of University Court, The University, Glasgow (March 12)

Lecturer in Engineering—The Secretary, The University, Aberdeen (March 12)

Cereal Technician (with intermediate B Sc or equivalent qualification, and preferably with a science background) **at the Agricultural Research Institute**, Wagga, Australia, to be responsible for the technical work involved in the assessment of wheat quality including laboratory milling, tests on dough quality and experimental bread making—The Agent-General for New South Wales, 56 Strand, London, W C 2 (March 14)

Assistant Lecturer in Physics—The Secretary and Registrar, University College of North Wales, Bangor, North Wales (March 15)

Assistant Lecturer in Theoretical Physics—The Registrar, The University, Manchester (March 16)

University Lecturer in Agricultural Zoology and Physiology of Farm Animals, and a **University Demonstrator in Agricultural Entomology**—The Secretary, School of Agriculture, Downing Street, Cambridge (March 16)

Research Officer (with a university honours degree in science, with chemistry, botany or biochemistry as major subjects, and preferably some research experience in mycology) **in the Biochemistry Unit**, Wool Textile Research Laboratories, Melbourne, Australia, to take part in a programme of research on cellulose-destroying fungi with special reference to the nutritional requirements of particular moulds, the nature of the enzymes produced and their mode of action on cellulose—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting 462/69 (March 19)

Head of the Department of Entomology—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (March 31)

Lecturer in Applied Mathematics—The Secretary and Registrar, The University, Southampton (March 31)

Technical Assistant (graduate, whose degree course included mathematics and/or physics, and a knowledge of a modern continental language) **in the School of Theoretical Physics**—The Senior Clerk, Dublin Institute for Advanced Studies, 64 Merrion Square, Dublin (March 31)

Scientific Officer (with a first- or second-class honours degree in an approved scientific subject or other approved qualifications, and preferably with industrial experience) **in the Department of Industrial and Forensic Science** of the Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast, N Ireland (April 1)

Director (with high attainments in one of the basic sciences relevant to the work of the Institute, and preferably with experience of horticultural crops) **of the Glasshouse Crops Research Institute**—The Secretary, Glasshouse Crops Research Institute, Worthing Road, Rustington, Sussex (April 15)

Lecturer in Applied Mathematics, and a **Lecturer in the Department of Civil Engineering** at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Cape Town, April 15)

Senior Lecturer (with a higher degree, for example Ph D or equivalent qualifications, and preferably with lecturing experience) **in Physics** at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (June 15)

Biologist (preferably with an honours degree in zoology or one of the natural sciences) **in the Department of Game and Tsetse Control** Northern Nigeria, for duties which include the administration of game conservation and control, with study of animal ecology generally, the habits of individual wild animals, significance of wild animals to tsetse and diseases of stock—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 152/3/01

Chemical Technician (preferably with experience in a biological laboratory) **in the Radioisotope Laboratory** at the Pollards Wood Research Station, Chalfont St Giles, Bucks—The Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S W 3, quoting "Chemical Technician"

Experimental Officers (preferably with a pass degree in chemistry and experience in microchemical analytical techniques) to assist in basic research in inorganic chemistry and metallurgy—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 512/WGE/34

Lecturer (preferably with an honours degree in agriculture, horticulture or engineering, and experience in teaching and research) **in Farm Mechanization and Agricultural Engineering**—The Registrar, Wye College, near Ashford, Kent

Lecturer (with industrial engineering experience and also experience in research) **in Mechanical Engineering**—The Registrar, Queen Mary College (University of London), Mile End Road, London, E 1

Master to teach **Botany** and **Zoology** in the Sixth Forms—The Headmaster, St Dunstan's College, London, S E 6

Mathematicians (with a first- or second-class honours degree in mathematics, and preferably some research experience in an applied field) at various Ministry of Supply Research and Development Establishments in Southern England—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 28/5A

Scientific Officers (with a first- or second-class honours degree or equivalent in mathematics or mathematical physics), at the Royal Aircraft Establishment, Farnborough, Hants, for research and development on targets for guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 36/5A

Scientific Officers (with at least a first- or second-class honours degree in chemistry, and preferably with research experience in physical chemistry), for basic research in inorganic and metallurgical chemistry—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 511/WGE/34

Senior Experimental Officer or **Experimental Officer** (with at least H S C in physics or equivalent qualification in electrical engineering, and preferably with experience of metal vacuum systems and/or high voltage equipment), to take charge of the running, maintenance and improvement of a high voltage ion accelerator used for nuclear physics research—The Establishments Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/233

Senior Experimental Officer (with at least H S C (science) or equivalent, and several years appropriate experience in an industrial laboratory), at Sellafield, Cumberland, to undertake experimental work in metallurgy and physics—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P O Box 19, Risley, Warrington, quoting 797

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Department of Scientific and Industrial Research Fire Research—Technical Paper No 2 Report of Committee on Vapourizing Liquid Extinguishing Agents Pp vi+14 (London H M Stationery Office, 1954) 1*s* net [712

City of Leicester Museum and Art Gallery 48th Report to the City Council—1st April 1953 to 31st March 1954 Pp 46+4 plates (Leicester City of Leicester Museums and Art Gallery, 1954) [712

Colonial Office Colonial Research Studies No 14 The Land Dayaks of Sarawak—a Report of a Social Economic Survey of the Land Dayaks of Sarawak, presented to the Colonial Social Science Research Council By Dr W R Geddes Pp 113+4 plates (London H M Stationery Office, 1954) 32*s* 6*d* net [712

Ministry of Pensions and National Insurance Digest of Statistics Analysing Certificates of Incapacity, 1951 and 1952 Pp 21+92 tables (London Ministry of Pensions and National Insurance, 1954) [712

Bulletin of the British Museum (Natural History) Entomology Vol 3, No 12 The Genera *Henricohahnia* Breddin, *Dicrotelus* Erichson, *Nyllius* Stål, *Orgetorixa* China and Allied New Genera By N C E Miller Pp 445–488 12*s* 6*d* Zoology Vol 2, No 10 The Otariid Seals of the Pacific Coast of America By Judith E King Pp 309–337+plates 10 and 11 8*s* (London British Museum (Natural History), 1954) [912

Other Countries

Conseil Permanent International pour l'Exploration de la Mer, Charlottenlund Slot, Danemark Bulletin Hydrographique pour l'Année 1950 Publié par Le Bureau du Conseil, Service Hydrographique Pp x+114 (Copenhague Andr Fred Høst et Fils, 1954) 40 kronor [3011

United States Department of Agriculture Technical Bulletin No 1091 The Larvae and Pupae of the Mosquitoes belonging to the Culex Subgenera Melanoconion and Mochlostyrax By Richard H Foote Pp ii+126 50 cents Leaflet No 370 The Seed-corn Maggot How to Control It Pp 6 5 cents (Washington, D C Government Printing Office, 1954) [712

Tanganyika Records of the Geological Survey of Tanganyika Vol 1, 1951 Pp v+80+9 plates 7/50 shs Geological Survey Department Bulletin No 21 Geology of the Ketewaka-Mchuchuma Coalfield, Njombe District By A C M McKinlay Pp v+46+4 plates 12 shs (Dar-es-Salaam Government Printer, 1954) [71

University of Natal Wattle Research Institute (South Africa Wattle Growers' Union—University of Natal—Union Department o Forestry) Report for 1953–1954 (Seventh year) Pp 58 (Pietermaritzburg University of Natal, Wattle Research Institute 1954) [71

Kungl Sjokarteverket, Stockholm Ergebnisse der Beobachtunge des Magnetischen Observatoriums zu Lovo (Stockholm), im Jahr 1951 Von Nils Ambolt Pp 30 Ergebnisse der Beobachtungen de Magnetischen Observatoriums zu Lovo (Stockholm), im 1954 Vo Folke Eleman und Kjell Borg Pp 30 (Stockholm Statens Reproduktionsanstalt, 1953 and 1954) [71

Building Research in Canada—a Progress Report Vol 1, No (June 1954) Pp iv+201–240 (Ottawa National Council—Divisio of Building Research, 1954) [71

University College, Ibadan, Nigeria Calendar, 1954–55 Pp 36 (Ibadan University College 1954) [91

University College of Khartoum, Sudan First Annual Report of th Hydrobiological Research Unit, July 1953 to June 1954 Pp 23 (Khartoum University College, 1954) [91

United States Department of Agriculture Farmers' Bulletin No 2074 American Foulbrood of Honey Bees How to Control It B A S Michael Pp 12 (Washington, D C Government Printin Office, 1954) 10 cents [91

Editorial and Publishing Offices of " NATURE "
MACMILLAN & CO, LTD,
ST MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare Londo

Annual subscription £6, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to
T. G Scott & Son, Ltd , Crown House, 143–147 Regent Street, London, W.
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Offic

NYGON
SEAL MATERIAL
(High vacuum equipment)

Nygon seal material is specially prepared for high vacuum sealing. It is made in 'O' Rings and sheet form, is black in colour with a highly polished surface and has a shore hardness of approximately 50°.

Send your enquiries to
ELECTRICAL LIMITED
NASSAU MILL PATRICROFT MANCHESTER
TELEPHONE ECCLES 1643

Hutchinson's

Out next Monday:

ORIGIN AND DISTRIBUTION OF THE BRITISH FLORA

J. R. Matthews

An inquiry into the origin and geographical relationships of our native flora which examines not only the present-day distribution of British plants but also their occurrences in prehistoric times

Still available:

A HISTORY OF BIRDS

James Fisher

"Almost all the information one could want about the place of birds in the animal kingdom is available in outline in this handy little book"
COUNTRY LIFE

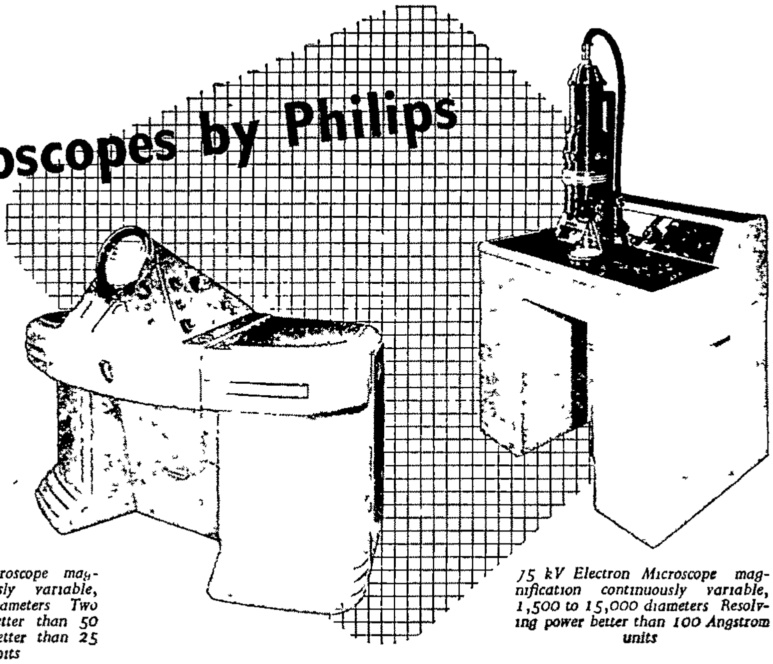
Both volumes illustrated and 8s 6d. net

University Library

Electron Microscopes by Philips

ompact, simple to control, completely afe to operate—these instruments pen new fields in sub-microscopic esearch. A special feature is their 'oscillating beam" device, which nsures immediate and exact focusing

end to-day for literature giving complete formation



100 kV Electron Microscope magnification continuously variable, 1000 to 60,000 diameters Two models available—better than 50 Angstrom units or better than 25 Angstrom units

75 kV Electron Microscope magnification continuously variable, 1,500 to 15,000 diameters Resolving power better than 100 Angstrom units

PHILIPS

PHILIPS ELECTRICAL LTD
X-RAY DIVISION
CENTURY HOUSE SHAFTESBURY AVENUE · LONDON W C 2
(PXI 0070A)

LECTURES AND COURSES

CHELSEA POLYTECHNIC

MANRESA ROAD, S W 3
(Telephone FLAxman 5747)

Full-time courses and part-time day and evening courses are arranged in biology, botany, chemistry, geology, mathematics, physics, physiology, zoology, in preparation for the preliminary (intermediate) science examination and the B Sc general degree of the University of London for internal and external students, and for professional examinations Full-time or part-time courses are also held for the B Sc internal special or honours degrees in botany, chemistry (full-time only) geology, mathematics, pharmacy, physics, physiology (evening only) and zoology Facilities are provided for research and postgraduate study and short courses of lectures are held on special topics Full-time courses are arranged for professional qualifications in pharmacy and chiropody There are special evening courses in food and drugs, gemmology, industrial microbiology, and surgical technicians work

Applications for enrolment for the Session 1955-6 may now be made on forms to be obtained from the Principal

---

GRESHAM COLLEGE

BASINGHALL STREET, LONDON, E C 2

Four lectures by Professor H Hartridge, M A, M D, Sc D, M R C P, F R S (Gresham Professor in Physic), on "Some Mechanisms of the Body," Monday to Thursday February 21 to 24 The lectures are free and begin at 5 30 p m

---

STATISTICAL METHODS IN INDUSTRY

A short, residential course in PRACTICAL STATISTICAL CALCULATIONS suitable for scientists and technologists engaged in research and development, process and quality control, operational research and all kinds of investigational work will be held in Cambridge June 28 to July 7—Details from the Organizer, 18 Nightingale Road, Hampton, Middlesex

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952

COMMONWEALTH AGRICULTURAL BUREAUX

COMMONWEALTH INSTITUTE OF ENTOMOLOGY

Applications are invited for an appointment as Acarologist, whose principal duty will be the determination of phytophagous and predatory mites of economic importance, but who would also enjoy excellent opportunities for general systematic work in the Acarina Candidates are sought who show evidence of special interest or achievement in this field The successful candidate would work in the British Museum (Natural History), London The salary will be in a scale that rises from £530 by annual increments to £1,540 per annum, with efficiency bars at £855 and £1 150 There is also a pay supplement that runs from £25 at £530 to £35 at £900 to £1,500 The starting salary will be determined by age, qualifications and experience Superannuation will be provided for under the F S S U

The closing date for applications is April 30 1955, and full details of the appointment and methods of application can be obtained from the Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S W 7

EMPIRE COTTON GROWING CORPORATION

Entomologist required in August, 1955, to work on cotton and other crops in the Research Section of the Agricultural Department, Aden Postgraduate experience an advantage, but not essential Salary according to qualifications and experience but not less than £1,100, including local allowance Free quarters, leave passages and admittance, after probationary period to the Staff Assurance Scheme to which the Corporation contribute 21 per cent of basic salary

Applications, with names and addresses of two referees, to the Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S W 1

SHORT SERVICE COMMISSIONS IN THE INSTRUCTOR BRANCH OF THE ROYAL NAVY

Applications are invited from university graduates and qualified teachers under 36 years of age for Short Service Commissions of 3, 4, or 5 years in the Instructor Branch, Royal Navy Applications will also be accepted from final year undergraduates, and these will be considered in anticipation of their degree results Requirements are mainly for officers with qualifications in mathematics, science (physics, chemistry, metallurgy), or engineering, but a few vacancies exist for officers with qualifications in history or English with a sound mathematics or science background After two years' service, officers will be eligible for selection for permanent commissions A Short Service engagement in the Instructor Branch will discharge any candidate's obligation under the National Service Acts Entry will be in two grades Selected candidates with first- or second-class honours degrees receive approximately £410 in their first year's service, £429 in second year, £548 in third and fourth years, £584 in fifth year Other candidates receive £319 in first, £392 in second and third years, £429 in fourth and fifth years Previous officer service will be recognized for adjustment of seniority and rate of pay on entry Accommodation and rations are provided or allowances in lieu Married officers if aged 25 or over receive marriage allowance of £338 per annum if not accommodated in official married quarters, £283 per annum if they are so accommodated Married officers under the age of 25 receive marriage allowance of £146 per annum, but are not entitled to be accommodated in official married quarters An initial outfit allowance of £115 is paid, together with a free issue of certain articles of clothing A reduced allowance is payable to candidates with previous Naval Service as officers Tax free gratuities of £300, £400 or £500 are payable at the end of 3, 4 or 5 years respectively Instructor Officers serve both ashore and afloat and their duties include both technical instruction and general education Officers with suitable qualifications may also be trained and appointed for full- or part-time meteorological and weather forecasting duties Service in the Instructor Branch will, in the case of officers who enter from contributory service under the Teachers (Superannuation) Acts, be treated as contributory service, contributions being deducted from the above gratuities Other officers may have their service in the Instructor Branch similarly treated if they so desire

Fuller details and application forms may be obtained from Director (P) Naval Education Service, Admiralty, London, S W 1 Completed application forms should be returned, if possible, before May 31, 1955

McMASTER UNIVERSITY

DEPARTMENT OF PHYSICS
GRADUATE ASSISTANTSHIPS

Applications are invited for part-time teaching and research assistantships in the Department of Physics, McMaster University, from persons qualified to register in courses leading to the M Sc and Ph D degrees Assistantships normally carry a yearly stipend of $1,450 to $1,850 Assistants are required to devote 10 to 12 hours per week to duties during the academic session (October to April inclusive) and are able to devote full-time to their research during the summer Research is in progress in the following fields Theory of Molecular Spectra, F R Britton, Atomic Mass Determinations, H E Duckworth, Cosmic Rays, F Gulbis, Beta and Gamma Spectroscopy, M W Johns, Microwave Diffraction, A B McLay, Solid State, H E Petch, Theoretical Nuclear Physics, M A Preston, Fission Yields and Isotopic Abundances, H G Thode

Interested persons should write to Dr H E Duckworth, Department of Physics, Hamilton College, McMaster University, Hamilton, Ontario, Canada

---

UNIVERSITY OF BRISTOL

DEPARTMENT OF AGRICULTURE AND HORTICULTURE
RESEARCH STATION LONG ASHTON, BRISTOL

Applications are invited for the post of Scientific Assistant for Greenhouse Experiments to take charge of the experimental work with sand and water cultures in connection with investigations on the mineral nutrition of fruit crops The appointment will be in the Assistant Experimental Officer grade under the scheme of the Agricultural Research Council for Research Institutes

Further particulars may be obtained from the undersigned

A L LEGGETT,
Secretary

UNIVERSITY OF CAPE TOWN

PROVINCIAL ADMINISTRATION OF T
CAPE OF GOOD HOPE JOINT MEDICA STAFF

Applications are invited for the Chair Surgery in the University of Cape Town appointment will be made under the terms the Joint Staff Agreement between the Unive of Cape Town and the Provincial Administra of the Cape of Good Hope It is a full- appointment, and the occupant of the Chai not permitted to undertake remunerative pri work The salary is £2,500 per annum, plu temporary cost-of-living allowance (at pre £320 per annum for a married man and per annum for others) The professor is Hea the Division of Surgery He will be in charg surgical beds in Groote Schuur Hospital

Applications (with copies of testimonials) sh state age, experience, qualifications and rese work, completed or in progress, and give names of two referees whom the University consult Two copies of the application testimonials should reach the Secretary, Ass tion of Universities of the British Commonwe 5 Gordon Square, London, W C 1 (from w a memorandum giving the general condition appointment should be obtained), not later April 30, 1955 An additional copy shoul sent direct by air mail to the Registrar, versity of Cape Town, Private Bag, Rondebo Cape Town, South Africa, by the same date University reserves the right to recommend appointment of a person other than one of applicants, or to recommend no appointment

---

UNIVERSITY OF CAPE TOWI

SOUTH AFRICA

Applications are invited for a Senior Lec ship in Land Surveying The substantive s scale is £1,200 by £50 to £1,450 per an There is also a temporary cost-of-living allow for a married man (at present £234 per ann The salary scale recognized for the Provi Fund is £1,050 by £50 to £1,400 per annum

Applications (with copies of testimonials) sh state age, experience, qualifications and rese work, completed or in progress, and give names of two referees whom the University consult Two copies of the application testimonials should reach the Secretary, Ass tion of Universities of the British Commonwe 5 Gordon Square, London, W C 1 (from whc memorandum giving the general conditions o pointment should be obtained), not later April 15, 1955 An additional copy shoul sent direct by air mail to the Registrar, versity of Cape Town, Private Bag, Rondeb Cape Town South Africa, by the same date University reserves the right to appoint a pe other than one of the applicants, or to r no appointment

---

NOTTINGHAM NO 1 HOSPITA MANAGEMENT COMMITTEE

Applications are invited for the full-time pointment of Non-medical Biochemist (S grade) at the General Hospital, Nottingham beds) Whitley Council conditions of se apply

Applicants should send details of qualifica and experience, together with names and addr of two referees, to reach the Secretary Ge Hospital Nottingham, by March 5 1955

UNIVERSITY OF CAMBRIDG

SCHOOL OF AGRICULTURE

Applications are invited for three post Assistant in Research from October 1, 195 the following subjects agricultural enginee animal physiology, soil science Qualifica should include an honours degree in appro subjects The stipends of Assistants in Res are under review The present stipend is rising by annual increments of £25 to £600 posts are pensionable under the F S S U non-pensionable allowance of £50 a year is in respect of each dependent child under th of sixteen or in receipt of full-time educati

Applications should be made in writin reach the Secretary, School of Agriculture, D ing Street, Cambridge, not later than Marc 1955

MID-ESSEX TECHNICAL COLLE

MARKET ROAD, CHELMSFORD

Two adult Laboratory Stewards required i diately for (a) chemistry (b) instrument ma Salary £350 by £15 by £20 to £460 Su candidates may be considered for post of S Laboratory Steward Salary £440 to £520 salary scales are under review)

Details and application forms from Cle the Governors

UNIVERSITY OF CAPE TOWN

SOUTH AFRICA

Applications are invited for a Lectureship in
pplied Mathematics in the Department of
athematics, and for a Lectureship in the Depart-
:nt of Civil Engineering For the Lectureship
Civil Engineering preference will be given to
ndidates who have either practical or research
perience in (a) structural engineering or (b) in
: practical applications of soil mechanics The
ary scale is £850 by £50 to £1,150 per annum
e scale recognized for the Provident Fund is
)0 to £1,050 per annum) There is also a
nporary cost-of-living allowance for a married
in (at present £234 per annum)

Applications (with copies of testimonials)
ould state age experience, qualifications and
earch work, completed or in progress, and give
names of two referees whom the University
y consult Two copies of the application and
timonials should reach the Secretary, Association
Universities of the British Commonwealth, 5
rdon Square, London, W C 1 (from whom a
morandum giving the general conditions of ap-
ntment should be obtained), not later than
ril 15, 1955 An additional copy should be sent
ect by air mail to the Registrar, University of
pe Town, Private Bag Rondebosch, Cape
wn, South Africa by the same date The
iversity reserves the right to appoint a person
er than one of the applicants, or to make
appointment

SHEFFIELD EDUCATION COMMITTEE

KING EDWARD VII SCHOOL

Required for the Summer Term, 1955 an Assis-
t Master to teach physics to "A" level and
ne general science A special responsibility
owance of £90 will be available to a candidate
h suitable qualifications

Application forms obtainable from the Director
Education, Education Office, P O Box 67,
effield, 1 (stamped, addressed envelope) to
om they should be returned not later than
oruary 25, 1955

HILL END HOSPITAL

ST ALBANS, HERTS

Biochemist (non-medical, senior grade), univer-
' graduate, required for duties in the patho-
ical department at the above hospital situated
hin half an hour's train journey of Central
idon Duties consist of routine and more ad-
ced biochemical techniques and research ex-
ience will be an advantage Salary and condi-
is of service according to Whitley Council
Applications to the Consultant Pathologist

DEPARTMENT OF SCIENTIFIC AND IN-
trial Research require Scientific Officer (un-
iblished) at Torry Research Station, Aberdeen,
training in research and development work on
ine applications of refrigeration involving
ls of duty at sea in trawlers First- or second-
s honours degree in engineering or equivalent
lification Some postgraduate research experi-
: would be an advantage Minimum age 21
spects of establishment for candidates under
Inclusive annual remuneration for a 45½ hour
k within the range £481 to £870 (men) £481 to
2 (women)—Application forms from Ministry
Labour and National Service, Technical and
ntific Register (K), 26 King Street, London,
'1 Quoting Ref C60/5A Closing date
ch 5 1954

NIVERSITY OF LONDON, KING'S COL-
will require on October 1, 1955, a Lecturer
Vertebrate Zoology The duties will include
onsibility for the organization of the teach-
in that subject Salary scale £700 by £50 to
00, £1,050 by £50 to £1,400 with family
wances and superannuation benefits—Particu-
and application forms should be obtained
i the Registrar, King's College, Strand,
2 whom completed applications must reach
March 18

HEMIST (METALLURGIST) REQUIRED BY
istry of Supply at Radway Green, near Crewe,
evelop control of metallurgical operations in
ine production of small arms ammunition fac-
Investigation of ferrous and non-ferrous
lems arising in course of production and ex-
nental development of drawn components
lifications British of British parents Hons
ee metallurgy or A I M or equivalent Prac-
experience of laboratory and investigational
k and supervision of staff Salary Within
(age 25) to £995 according to age Not
blished, but opportunities to compete for
blishment may arise—Applications from
istry of Labour and National Service Tech-
l and Scientific Register (K) 26 King Street,
don, S W 1, quoting F 31/54A

H M OVERSEA CIVIL SERVICE

Applications are invited for the following post Biologist (Game Officer), Northern Rhodesia Vacancy for a Biologist in the Department of Game and Tsetse Control Northern Rhodesia Duties include administration of game conservation and control, with study of animal ecology generally, the habits of individual wild animals, significance of wild animals to tsetse and diseases of stock Qualifications Candidates must possess a university degree (preferably with honours) in zoology or one of the natural sciences Terms of Appointment Pensionable in Her Majesty's Oversea Civil Service after a probationary period of two years Emoluments Salary scale £625 to £1,515 a year Point of entry into the salary scale depends on qualifications and experience Cost of living allowance of between £108 and £256 a year Outfit allowance £30, if initial salary below £975 a year Government quarters when available at rental of not more than 10 per cent of basic salary Free passages for officer and wife and up to one full fare for children on first appointment and leave Taxation at local rates

Apply, giving brief particulars, to the Director of Recruitment Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting reference BCD 152/3/01

H M OVERSEA CIVIL SERVICE

Applications are invited for the following post Plant Physiologist, Kenya A Plant Physiologist is needed in the Government Service in Kenya, to investigate diseases of coffee berry at the Coffee Research Station, Ruiru Candidates must have or expect to be awarded this year a degree in natural science and have been trained in plant physiology Appointment either pensionable, or on contract for 40 to 48 months with salary of between £852 and £1,620 a year, plus non-pensionable cost-of-living allowance of ten per cent Initial salary according to qualifications and experience Contract appointment leads to a gratuity of 13½ per cent of total substantive salary payable on satisfactory termination of contract Government quarters provided at reasonable rental charge Outfit allowance £30 when initial salary of £1,092 a year or less Free first-class passages for officer and family up to equivalent of three adult passages Income tax at local rates

Apply with brief particulars, to the Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting reference BCD 63/7/015

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)

MILE END ROAD, E 1

Applications are invited from candidates with special qualification in statistics for appointment as Lecturer in the Department of Mathematics Salary scale £700 by £50 to £1,000 by £50 to £1,400, commencing salary according to age and experience, with F S S U participation and family allowance of £50 for each child

Application forms (obtainable from the Registrar) should be returned by February 28

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)

MILE END ROAD, E 1

Applications are invited for appointment as Lecturer in the Department of Botany, to take charge of ecological work, and preferably with an interest in taxonomy and morphology Salary scale £700 by £50 to £1,000 by £50 to £1,400, commencing salary according to age and experience with F S S U participation and family allowance of £50 for each child

Application forms (obtainable from the Registrar) should be returned by February 28

UNIVERSITY OF SOUTHAMPTON

Applications are invited for the post of Lecturer in Applied Mathematics Salary depending on qualifications and experience, within the range £650 to £1,350 per annum, together with F S S U and children's allowances

Further particulars may be obtained from the Secretary and Registrar, to whom applications (six copies) should be sent not later than March 31, 1955

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Assistant Lecturer in Theoretical Physics Salary on a scale £450 to £550 per annum (salary scales are at present under review) Membership of F S S U and children's allowance scheme

Applications should be sent not later than March 16, 1955, to the Registrar The University, Manchester, 13, from whom further particulars and forms of application may be obtained

---

CAVENDISH LABORATORY

CAMBRIDGE

There is a vacancy for a temporary Research Assistant in a small team engaged in the study of plastic deformation by X-ray diffraction, electron microscopy and optical methods The successful candidate will be required to grow metal single crystals and to develop etching and polishing techniques The appointment will be for not more than three years and will be preceded by a probationary period The salary offered, which will be in the range £400 to £650 per annum, will depend on age and experience

Applications should be sent to the Secretary to the Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge, so as to reach him not later than two weeks after the appearance of this advertisement

---

NATIONAL COAL BOARD

SOUTH-WESTERN DIVISION

Applications are invited for the post of Scientist Grade 2, in the Board's Divisional Laboratory at Ystrad Mynach, near Cardiff Minimum qualification Good honours degree in chemistry Salary on the scale £800 by £35 to £1,150 per annum Candidates should preferably be 30-35 years of age, and at this age the salary would be approximately £1 000 per annum Candidates should have a wide experience of industrial chemistry or chemical engineering and should have undertaken short term investigations into difficulties arising in plant operation etc

Full details of experience, etc, should be sent to Secretariat (E) National Coal Board Cambrian Buildings, Mount Stuart Square, Cardiff, by March 1, 1955

UNIVERSITY OF OXFORD

DEPARTMENT OF FORESTRY

MICROBIOLOGY SECTION

Laboratory Technician required for work on plant constituents Experience in organic-chemistry research work is required Opportunity given to study for further qualifications Hours 9 to 5 Monday to Friday, 9 to 1 Saturday Salary on scale £315 by £15 to £450 (efficiency bar at £390)

Apply Secretary, Department of Forestry, Imperial Forestry Institute, University of Oxford

---

NEW SOUTH WALES UNIVERSITY OF TECHNOLOGY

Applications are invited for Monsanto Research Scholarship in Chemical Engineering The duration of the Scholarship is for one year and the annual value is £A 700 The Scholarship may be extended in certain circumstances, for a further twelve months at the same rate Applicants should hold a degree in science or engineering

Applications, indicating qualifications, proposed field of research and names of two referees, should be forwarded to the Registrar, N S W University of Technology, Broadway Sydney, New South Wales, Australia, before March 21, 1955

ELECTRICAL RESEARCH ASSOCIATION

Technical Assistant required for Research on Applications of Electricity in Horticulture Candidates should have a good degree in electrical engineering or physics or equivalent qualifications Research experience an advantage Starting salary will be in the range of £500 to £600 per annum, with superannuation provisions

Applications should be addressed to the Director, E R A Field Station Shinfield Green near Reading, to arrive not later than February 28, 1955

CHEMICAL ENGINEER REQUIRED AT Ministry of Supply Establishment in S W England to be concerned with development of chemical processes involving semi-technical research, design and operation of pilot units and basic research in chemical engineering operations Qualifications, first- or second-class honours degree or equivalent qualification in chemical engineering Postgraduate experience related to above duties would be an advantage A house may be available shortly for selected candidate, if married Salary within Scientific Officer range, £467 10s to £845 F S S U benefits may be available—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House 26 King Street London S W 1, quoting F60/5A Closing date March 12, 1955

UNIVERSITY COLLEGE LONDON (Gower Street, W C 1) has vacancy for Technician in Department of Chemical Engineering, to assist in preparation of Co-enzyme "A"—Application form from Secretary, quoting Chem Eng /3

UNIVERSITY OF SHEFFIELD

Applications are invited for the T I Research Fellowship, tenable in the Department of Metallurgy The object of the Fellowship is to advance knowledge in the field of metallurgy, candidates should already have some research experience, but not necessarily in this field Normal tenure will be five years, but the appointment will be for two years in the first instance and thereafter will be renewable annually Stipend £750 per annum for the first year rising by annual increments of £50 to £950 per annum together with superannuation provision under the F S S U A higher stipend may be paid to an exceptional candidate

Applications (three copies) including the names and addresses of referees, and, if desired, copies of testimonials, should reach the Registrar (from whom further particulars may be obtained) not later than March 31 1955

SCIENCE AND INDUSTRY COMMITTEE

Two Research Workers, with qualifications in economics or other social science or allied subjects, or in science or technology, are required by the Science and Industry Committee, which is studying the problems of speeding up the industrial application of the results of scientific research The appointments will be for one year in the first place, at a salary of £550 to £850, according to qualifications and experience

Further particulars may be obtained from Professor C F Carter, The Queen's University, Belfast Final date March 14

SCOTTISH SOCIETY FOR RESEARCH IN PLANT BREEDING

Experimental Officer (male) required at the Scottish Plant Breeding Station to take charge of organization and conduct of field work connected with the Station's scientific programme The officer will be attached to and assist the Cereals Research Section Qualifications must include a Degree or Diploma in Agriculture Salary scale £735 to £900 (intermediate), with placing according to experience and qualifications Superannuation scheme for Experimental Officers Assistant Experimental Officer (male) required to assist in Cereals Research Section Qualifications must include Degree or Diploma in Agriculture or Botany Salary scale £392 10s, at age 21, to £655 (intermediate), with placing according to experience and qualifications Superannuation scheme as for Experimental Officer class

Applications, which should give the names of two referees, must be lodged not later than March 1, 1955 with the Secretary, Scottish Plant Breeding Station Pentlandfield Roslin Midlothian

---

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE BRADFORD

BRADFORD DYERS' ASSOCIATION RESEARCH FELLOWSHIP

Applications are invited for a Research Fellowship provided by the Bradford Dyers' Association Limited and tenable in the College for two years The minimum value of the Fellowship will be £600 per annum the commencing rate depending upon qualifications and experience The Fellow should hold high qualifications in science He will be required to undertake research in the College in tinctorial chemistry, textile chemistry or an allied subject

Forms of application may be obtained on application to the Principal, Technical College, Bradford

---

NORTHERN POLYTECHNIC

HOLLOWAY LONDON N 7

The Governing Body invite applications for appointment as Principal of the Northern Polytechnic Candidates should possess high academic qualifications and appropriate educational and administrative experience Salary scale £1 890 by £75 to £2 190 plus London allowance Duties will commence on January 1 1956

Form of application together with full particulars, will be forwarded on request

R H CURRELL A S A A

Clerk

MANCHESTER REGIONAL HOSPITAL Board will shortly have a vacancy for a male or female Junior Scientific Officer in the Blood Transfusion Service An honours degree in science pharmacy or biology is essential Duties will consist of technical work in the Blood Transfusion Service Laboratories—Applications stating age, qualifications previous experience (if any) and the names and addresses of two referees should be sent immediately to the Director Blood Transfusion Service Roby Street Manchester 1 from whom further particulars may be obtained

---

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

LECTURER IN CHEMICAL ENGINEERING

The Governing Body invites applications for a Lectureship in Chemical Engineering in the College of Technology, with the title and status of Lecturer in the University of Manchester Candidates should be graduates in chemical engineering or graduates in chemistry with postgraduate training and/or experience in chemical engineering and will be expected to undertake research in chemical engineering Salary £650 per annum, rising by annual increments of £50 to £1,350 per annum Commencing salary according to qualifications The salary scale is at present under review

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester, 1 The last day for the receipt of applications is March 18, 1955

B V BOWDEN,

Principal of the College

H M OVERSEA CIVIL SERVICE

GEOLOGISTS

Permanent and pensionable vacancies at present exist for Field Geologists in the Geological Survey Departments of the following territories East Africa Kenya and Tanganyika Central Africa Nyasaland Northern Rhodesia West Africa Federation of Nigeria, Sierra Leone South-East Asia Federation of Malaya Other Territories Somaliland Protectorate, Bechuanaland, British Guiana Qualifications are a university degree, with first- or good second-class honours in geology

Candidates, including final year honours men who take their degree examination in 1955 should write, giving brief details of age qualifications and experience, to the Director of Recruitment, Colonial Office, Oversea Service Division, Sanctuary Buildings Great Smith Street S W 1 (quoting reference BCD 104/04), for further details of terms and conditions of service

---

DONCASTER HOSPITAL MANAGEMENT COMMITTEE

Applications are invited from suitably qualified persons for the post of Biochemist (basic grade) at Doncaster Royal Infirmary Candidates should possess a science degree

Applications, stating age, education, qualifications experience and present position, together with the names of three referees should be forwarded to reach the undersigned not later than a fortnight after publication

A JONES,

Secretary to the Committee

Doncaster Royal Infirmary

UNITED BIRMINGHAM HOSPITALS

BIRMINGHAM AND MIDLAND HOSPITAL FOR WOMEN

SHOWELL GREEN LANE BIRMINGHAM, 11

Applications are invited for the post of Technician to the Biological Section of the Department of Clinical Endocrinology Duties will include routine biological assays and assistance with biological research Salary and conditions of service will be in accordance with Whitley scales

Applications stating age qualifications and experience accompanied by two recent testimonials, should be submitted to the House Governor

---

UNIVERSITY OF SHEFFIELD

Applications are invited for the newly established Chair of Applied Mathematics to be filled as soon as possible The term "Applied Mathematics" is to be interpreted in a wide sense—e g a candidate whose field is theoretical physics or astrophysics or meteorology would be acceptable Salary £2 150, with F S S U provision and family allowance

Further particulars should be obtained from the Registrar The University Sheffield 10 to whom applications should be sent by April 2 1955

SENIOR ASSISTANT CHEMIST TAR Works South-Eastern Gas Board Greenwich A vacancy exists for a qualified chemist to develop methods of organic analysis to investigate problems arising in tar distillation and the use of tar products and to carry out analytical work of a non-routine nature Previous experience is not essential Starting salary not less than £655 per annum—Applications in writing giving full details and quoting reference V29/487 to Personnel Manager Katherine Street, Croydon, within fourteen days

---

COMMONWEALTH of AUSTRALI

WOOL TEXTILE RESEARCH LABORATORI

APPOINTMENT NO 464/94 OF PHYSICI OR ENGINEER

The Commonwealth Scientific and Industi Research Organization invites applications for pointment to a position of Senior Research Offi or Research Officer (Physicist or Engineer), G long Victoria Duties To carry out devel mental work on wool textile machinery Qua cations University honours degree in science engineering Industrial experience in resea and development preferable but not essent Salary Dependent on qualifications and exp ence, commencing salary will be determined wi in the range of Senior Research Officer, £A 1, to £A 1,750 per annum actual, £A 30 incremer subject to efficiency review at £A 1,366 per ann nominal, or Research Officer, £A 1 058 £A 1,412 per annum actual, thirteen increme subject to efficiency review at £A 908 and £A 1, per annum nominal Salary includes a cost living adjustment of £A 198 per annum Fare Australia (including those of wife and family) be paid The appointment is subject to satis tory medical examination and the appointee r be granted superannuation privileges

Applications referring to Appointment N 464/94 and stating full name, place, date and y of birth, marital state, nationality present emp ment particulars of qualifications and experie and of war service, if any, accompanied by co of not more than four testimonials, and the na and addresses of at least two persons willing act as referees, if required, should reach undersigned not later than March 19, 1955

W IVE

Chief Scientific Liaison Offi

Australian Scientific Liaison Office,
Africa House,
Kingsway London, W C 2

FISHERIES RESEARCH APPOINTMENT IN UGANDA

Vacancy for a Scientific Officer or Se Scientific Officer, to carry out research into ecology and/or physiology of fish at the J (Uganda) Laboratories of the East Afr Fisheries Research Organization Qualificatio First-class honours degree in a natural scie and at least two years' postgraduate research perience, preferably of freshwater fish fisheries Emoluments These consist of sal overseas research allowance and variable cost living allowance in the following ranges Sc tific Officer, £675 to £1 066 a year, Senior Sc tific Officer, £1,194 to £1 579 a year Th rates are under revision and will be increa Grade and point of entry into the basic sa scale depend upon age, qualifications and perience Salary scales for women somev lower Outfit allowance £60 Contribu superannuation scheme Income tax at l rates Free passages on appointment and l for officer, wife and children under 13 year age

Apply to the Director of Recruitment, Colo Office, Sanctuary Buildings, Great Smith St London, S W 1 giving brief indication of q fications and quoting reference BCD 195/194

ROYAL HOLLOWAY COLLEGI

UNIVERSITY OF LONDON

ASSISTANT LECTURESHIP IN MATHEMATICS (PURE OR APPLIED)

The Council invites applications for the pos Assistant Lecturer in Mathematics, tenable f October 1, 1955 which is open on this occas only to a woman The successful candidate be expected to be resident The salary will b the scale approved by the Senate of the Unive of London, according to experience with a n mum of £320 a year, plus board and reside In addition, the successful candidate will be by the increases which will be announced sho

Applications are required not later than M 1 Full particulars may be obtained from Principal Royal Holloway College Engle Green, Surrey

---

UNIVERSITY OF GLASGOW

LECTURESHIP IN CHEMISTRY (ORGAN CHEMISTRY)

Applications are invited for a Lectureshi Chemistry (Organic Chemistry) tenable f October 1 1955 Salary scale £650 to £1 Initial salary according to experience and qu fications F S S U and family allowance bene

Applications (six copies) should be lodged later than March 12 1955 with the undersig from whom further particulars may be obta

ROBT T HUTCHESO

Secretary of University Co

NEW SOUTH WALES
EPARTMENT OF AGRICULTURE
WAGGA, AUSTRALIA
\GRICULTURAL RESEARCH INSTITUTE
CEREAL TECHNICIAN

\pplications are invited for the above position ary in the range £A 897 to £A 1 067 per annum, ng to £A 1,271 per annum, subject to specified iditions Appointee will be responsible for the inical work involved in the assessment of :at quality including laboratory milling, tests dough quality and experimental bread making ierience in this type of work essential Ap- ntee should have the Intermediate B Sc or ivalent qualification Science background an antage Accommodation for married and ;le men being erected Appointee will be ible subject to medical examination, to contri- e to the State Superannuation Fund Shipping :s to Sydney of appointee and family will be l -

our copies of applications (together with four ies of testimonials and other supporting docu- its) should be lodged with the Agent-General New South Wales, 56 Strand, London, W C 2 m whom further particulars can be obtained), March 14, 1955

:OYAL HOLLOWAY COLLEGE
UNIVERSITY OF LONDON
\SSISTANT LECTURESHIP IN PHYSICS

he Council invites applications for the post Assistant Lecturer in Physics, tenable from)ber 1, 1955 The appointment is open to and women, but preference will be given to oman, who will be expected to be resident salary will be on the scale approved by the ite of the University of London, with a mini- 1 of £500 a year non-resident, or £320 a year board and residence In addition the suc- ful candidate will benefit by the increases :h will be announced shortly

pplications are required not later than March Full particulars may be obtained from the cipal Royal Holloway College, Englefield en, Surrey

---

JNIVERSITY OF CAMBRIDGE
SCHOOL OF AGRICULTURE

pplications are invited for the posts of Un - ty Lecturer in Agricultural Zoology and iology of Farm Animals and of University ionstrator in Agricultural Entomology Both s are tenable from October 1, 1955 The nds of university teaching officers are under :w The present stipend of a University Lec- : is £750, rising by annual increments of £50 1,250 and that of a University Demonstrator , rising by annual increments of £25 to £700 maximum tenure of a University Demon- orship is five years The stipends quoted may upplemented by a pensionable payment not :ding £120 a year upon the fulfilment of cer- conditions The posts are pensionable under F S S U A non-pensionable allowance of £50 ar is paid for each child under the age of 16 1 receipt of full-time education Qualifica- in each case should include an honours :e in appropriate subjects Postgraduate re- h or teaching experience would be an ntage

iplications should be made in writing to reach Secretary School of Agriculture, Downing t, Cambridge not later than March 16, 1955

WOOLWICH POLYTECHNIC
LONDON, S E 18

icipal J S Tait, Ph D , B Sc A R T C ,
M I E E , A M I Mech E

iplications invited for a Senior Lecturer in nic Chemistry from candidates with high emic and research qualifications, and able to , to special (honours) degree standard Salary £1,065 by £25 to £1,215, plus London 'ance

rticulars and application form from Clerk to :rnors to be returned by March 4, 1955

\THEMATICIANS REQUIRED AT VARI- Ministry of Supply Research and Development)lishments in Southern England Qualifica- First- or second-class honours degree in ematics, preferably with some research ex- nce in an applied field Appointments in tific Officer grade Salary range £467 10s to Women somewhat less F S S U benefits be available Prospects of promotion to)r Scientific Officer (minimum age 26), within y range £970 to £1,125 Not established but rtunities to compete for establishment may —Application forms from Ministry of Labour 'National Service, Technical and Scientific ;ter (K), 26 King Street, London, S W 1, ng A28/5A

UNIVERSITY OF ABERDEEN

Applications are invited for a Lectureship in Engineering Salary on scale (a), which is at present £550, rising by £50 to £800, but is expected to be substantially increased by revision now under consideration Placing within scale according to qualifications and experience Superannuation (F S S U) and children's allowances Part of expenses of removal of furniture to Aberdeen refunded Applicants should possess an honours degree, together with practical and/or research experience in civil or mechanical engineering

Conditions of appointment and form of application should be obtained from the undersigned, with whom applications (eight copies), should be lodged by March 12, 1955 Applicants outside the British Isles may submit one copy of application

W S ANGUS,
Secretary

The University, Aberdeen

INSTITUTE OF CANCER RESEARCH
ROYAL CANCER HOSPITAL

A vacancy exists for a Chemical Technician in the new Radioisotope Laboratory at the Pollards Wood Research Station, Chalfont St Giles, Bucks Experience in a biological laboratory would be helpful The post is permanent and superannuable, and canteen facilities are available Salary according to age and qualifications

Applications, with names of two referees to be sent to the Institute of Cancer Research Royal Cancer Hospital Fulham Road, London, S W 3, marking the envelope " Chemical Technician "

UNIVERSITY OF BIRMINGHAM
RESEARCH FELLOWSHIP IN ELECTRON PHYSICS

Applications are invited for a Research Fellowship tenable for one year, subject to renewal, in the Department of Electron Physics to the value of about £500 per annum with F S S U benefit and, where applicable, family allowance Preference will be given to a candidate who would wish to study ionic and other basic properties of the upper atmosphere, by means of laboratory experiments in the first instance

Applications, including the names of two referees, should reach the Registrar The University Edgbaston Birmingham, by March 26, 1955

G L BARNES,
Secretary

The University,
Edgbaston, 15

UNIVERSITY OF ST ANDREWS

The University Court of the University of St Andrews invites applications for appointment as Lecturer in Applied Mathematics in St Salvator's College St Andrews The salary will be on the scale £650 by £50 to £1,350 per annum commencing salary depending on qualifications and experience The post also carries F S S U benefits and family allowances, and a grant towards the expenses of removal may be made

Further particulars may be obtained from the undersigned with whom five copies of the application together with the names of three referees, should be lodged not later than March 31, 1955

D M DEVINE,
Joint Clerk to the University Court

UNIVERSITY COLLEGE
CORK
PROFESSORSHIP OF MATHEMATICS

The Governing Body hereby gives notice of its intention to appoint a Professor of Mathematics In order to be recognized as candidates, persons must pass an examination in Irish establishing their competence to carry out the duties of the office in Irish Salary £1,200 by £30 to £1 500 per annum, plus children's allowances Applications for admission to the examination in Irish will be received up to 12 noon on Monday, March 14, 1955

Full particulars of the Professorship may be had from the undersigned

JAMES HURLEY,
Secretary

STUDENT TECHNICIAN REQUIRED IN Surgical Unit, preferably having done National Service Previous experience not essential, but candidates must have knowledge of chemistry and physics Facilities for study for technician's examinations Salary scale from £5 12s per week at age 21 to £7 6s at age 26 —Apply immediately to Secretary, St Mary's Hospital Medical School, Paddington, W 2, stating age, experience and qualifications

---

GOLD COAST LOCAL CIVIL SERVICE
GOLD COAST

Crop Ecologist Department of Soil and Land-Use Survey, Gold Coast, to collect yield data for various crops grown on different soils Candidates must possess either (a) a good honours degree in botany, with postgraduate training in agriculture or agricultural botany and a sound grasp of statistics, particularly those concerning crop sampling, or (b) a degree in mathematics, with experience of statistical techniques and some knowledge of and interest in biometry or botany Appointment on contract in the salary scale £990 to £1,950 per annum, with a gratuity of £25 to £37 10s for each completed three months of satisfactory service Outfit allowance of £30 to £60 payable on first appointment Free first-class passages on appointment and leave for officer wife and up to three children under 13 years of age Generous home leave Taxation at local rates

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S W 1, giving briefly age, qualifications and experience Mention the reference number BCD 79/13/03

UNIVERSITY OF BIRMINGHAM

Applications are invited for a Research Fellowship in the Department of Chemistry for work on the mechanisms of changes produced in polymers by radiations The Fellowship will be tenable for two years and of a maximum annual value £750, depending upon qualifications and experience

Applications should be sent as soon as possible to the Registrar, The University, Edgbaston, Birmingham, 15

G L BARNES
Secretary

The University,
Edgbaston, 15

UNIVERSITY OF QUEENSLAND
AUSTRALIA

Applications are invited for the position of Senior Lecturer in Physics Salary range £A 1,500 to £A 1,750 per annum Applicants should possess a higher degree (e g , Ph D), or an equivalent qualification, in physics, and should preferably have had lecturing experience Research experience will be taken into account

Further particulars are obtainable from the Secretary Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 Applications close with the undersigned on June 15, 1955

C PAGE HANIFY
Registrar

UNIVERSITY OF QUEENSLAND
AUSTRALIA

Applications are invited for the position of Professor of Mathematics Salary £A 2,500 per annum Applicants should hold a higher degree, have taught at university level, and have carried out substantial research in the field of mathematics

Further particulars are obtainable from the Secretary Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 Applications close with the undersigned on March 31, 1955

C PAGE HANIFY,
Registrar

THE BRITISH COKE RESEARCH ASSOCIATION invite applications for the following posts (a) One Principal Scientific Officer (salary range £1 125 to £1 507) (b) One Senior Scientific Officer (salary range £970 to £1 125) (c) One Experimental Officer (salary range £715 to £880) (d) Two Assistant Experimental Officers (salary range £288 10s to £640) For post (a) applicants should be honours graduates or equivalent with wide industrial and technical experience The work will include the establishment of an information service on industrial effluent and pollution problems with special reference to the coking industry liaison duties and preparation of reports Posts (b), (c), and (d) involve operational research on practical problems related to coke ovens blast furnaces and foundries Duties will comprise work in different locations from time to time mainly in Yorkshire Midland and South Wales Coalfields Applicants for post (b) should be honours graduates or equivalent Some knowledge of statistical methods is essential For post (c) applicants should possess a pass degree higher national certificate or equivalent qualification —Applications stating age education training and experience, should be addressed to the Secretary, British Coke Research Association 74, Grosvenor Street, London, W 1

UNIVERSITY OF ST ANDREWS

The University Court of the University of St Andrews invites applications for a Lectureship in Marine Zoology in St Salvator's College The Lecturer will take up his duties in October, 1955, and will be a permanent member of staff of the Natural History Department Duties will include teaching in the department and research work carried out at the Gatty Marine Laboratory, St Andrews Preference will be given to candidates who propose to carry out research on the cytology or embryology of marine organisms The salary will be on the scale £650 by £50 to £1,350 per annum commencing salary according to qualifications and experience The post also carries F S S U benefits and family allowances, and a grant towards expenses of removal may be made

Further particulars may be obtained from the undersigned, with whom five copies of the application, together with names of three referees, should be lodged not later than March 31, 1955

D M DEVINE,
Joint Clerk to the University Court

UNIVERSITY OF LIVERPOOL

Applications are invited for the following posts in the Department of Physics (i) Lecturer (Grade II), for which candidates should have had experience in either experimental or theoretical nuclear physics, (ii) Assistant Lecturer or Lecturer in the Subdepartment of Acoustics, at initial salaries according to age, qualifications and experience within the ranges current at the time of appointment for Lecturers and Assistant Lecturers Both appointments will commence on October 1, 1955

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than April 14 1955 by the undersigned, from whom further details may be obtained

STANLEY DUMBELL,
Registrar

WOLVERHAMPTON AND STAFFORDSHIRE TECHNICAL COLLEGE

Principal S L Old, B Sc (Eng), M Sc (Tech)

Applications invited for post of Lecturer in Physical Chemistry The person appointed will assist with the teaching of chemistry at advanced level G C E, general degree and A R I C standard Salary Lecturers' scale, man £965 to £1 065 , women £772 to £852 per annum

Further particulars and application forms obtainable by sending a stamped, addressed foolscap envelope to the undersigned, to whom completed forms should be returned within fourteen days of the appearance of this advertisement

G W R LINES
Clerk to the Joint Education Committee
Education Offices
North Street, Wolverhampton

EAST MALLING RESEARCH STATION

Vacancy for an Assistant Statistician for the examination and analysis of experimental data A knowledge of both mathematics and horticulture (or botany) desirable Pass degree or equivalent qualification required Salary in the Ministry of Agriculture's Assistant Experimental Officer Grade

Application form and further particulars from the Secretary, East Malling Research Station near Maidstone Kent by whom applications should be received not later than March 15, 1955

UNIVERSITY OF NOTTINGHAM

CHAIR OF AGRICULTURE

Applications are invited for election to the Chair of Agriculture at the School of Agriculture, Sutton Bonington Present salary is £1,950 per annum, but salary scale is under review

Conditions of appointment may be obtained from the undersigned, to whom completed applications should be sent, if possible not later than March 16, 1955

H PICKBOURNE,
Registrar

HANNAH DAIRY RESEARCH INSTITUTE

The Council of the Institute propose to appoint a chemist with suitable experience as an Assistant Experimental Officer to do chemical analysis associated with grassland and other research Salary according to age in scale £330 at age 20 to £615 (men) £515 (women) with pay supplement ranging from £17 10s to £25 per annum Contributory superannuation scheme

Applications with names of two referees to the Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr, within two weeks

WEST AFRICAN FISHERIES RESEARCH INSTITUTE

Two vacancies exist in the West African Fisheries Research Institute, Sierra Leone for Marine Biologists (Scientific Officers), (i) to study the biology of marine fish, and (ii) for work in connection with ichthyology and planktology Qualifications Candidates must possess for (i) a first-class honours degree in zoology, and for (ii) at least a second-class honours degree in biology, preferably with two years' postgraduate experience Terms of Appointment On probation on terms applicable to the Research Branch of Her Majesty's Oversea Civil Service Emoluments These consist of salary and overseas research allowance in the Scientific Officer scale of £680 to £1,067 a year Point of entry into the salary scale depends upon age, qualifications and experience Outfit allowance of £60 on first appointment Contributory superannuation scheme Government quarters, when available, at a rental of up to 10 per cent of basic salary (maximum £150 a year) Free passages on appointment and leave for officer wife and children under 13 years of age Taxation at local rates

Apply, giving brief particulars to the Director of Recruitment Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting reference BCD 197/194/02

H M OVERSEA CIVIL SERVICE

Applications are invited for the following post Lecturer in Agriculture Tanganyika A Lecturer in Agriculture is needed in the Agricultural Department of the Government of Tanganyika, to teach at the Natural Resources School, Tengeru Candidates must be male between 25 and 45 years of age and possess a degree or diploma in agriculture and experience of teaching or lecturing in the subject Appointment on probation to the permanent and pensionable establishment if the officer is under 40 years of age (otherwise on contract terms), with salary in the scale £852 to £1,620 a year, plus a non-pensionable cost-of-living allowance of 10 per cent of salary Outfit allowance of £45 if initial salary is £1 206 a year or less Free passages on appointment and leave Government quarters, when available, at a rental of 10 per cent of salary Income tax at local rates

Apply, with brief particulars, to the Director of Recruitment, Colonial Office, Sanctuary Buildings Great Smith Street London, S W 1, quoting reference BCD 63/8/06

TECHNICIAN OR JUNIOR OR STUDENT Technician required for histological and microphotographic work, mainly in connection with research Salary scale, Technician, within range £470 to £545 Junior or Student Technician within range £150 to £393, according to age and experience —Apply in writing as soon as possible to Secretary, St Mary's Hospital Medical School, Paddington, W 2

BIOCHEMISTRY GRADUATE, PREFERABLY with some research experience, required for investigations on red-cell enzymes Salary up to £700 per annum, according to qualifications —Applications by April 15 1955 Further details from the Regional Director, Blood Transfusion Service, Royal Infirmary Edinburgh, 3

TECHNICIAN (MALE) REQUIRED IN THE Department of Chemical Pathology Salary on scale £450 to £515 per annum, with London weighting and superannuation Applicants should hold the A I M L T or an equivalent qualification —Apply in writing, giving details of experience to the Secretary Guy's Hospital Medical School, London Bridge, S E 1

VACANCIES IN THE METEOROLOGY Department, Imperial College London S W 7 (a) Experienced Physicist or Electrical Engineer with knowledge of electronics (salary £600 to £700), for work on clouds and rain (b) Physics Graduate, for research on thunderstorms (bursary £350) (c) Woman Mathematics Graduate for computational work (salary £400 to £450), ability to type an advantage Appointments for one year in first instance, starting as soon as possible, in any case before September 1 —Applications to the Registrar by March 15

MATHEMATICIAN AND PHYSICIST REQUIRED by Ministry of Supply Experimental Establishment, Porton, near Salisbury, Wilts, for operational research Qualifications First- or second-class honours degree in mathematics or physics Appropriate experience desirable Salary within Scientific Officer range £467 10s to £845 Women somewhat less F S S U benefits may be available —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 33/5A

NORTHAMPTON POLYTECHNIC

LONDON, E C 1

Chief Laboratory Technician for applied phys required Knowledge of physics and laborat and workshop experience necessary Post invol assisting in development of laboratories and a some responsibility for junior staff Prefere given to man keen on continuing his stud Five weeks paid holiday annually Superann tion scheme -Scale £503 by £25 10s to £ per annum

Apply by letter to the Secretary

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment Lecturer in Chemistry in the College Candid should possess experience in inorganic chemi and preferably in semi-micro analytical meth The salary scale for men (according to Burnham Technical Award) will be from £965 £1,065 per annum

Conditions of the appointment and forms application may be obtained from the Director Education, Town Hall, Bradford, 1, and c pleted forms should be returned to the Princ of the College as soon as possible

A SPALDING
Director of Educat

PHYSICIST REQUIRED BY NEWCAST Regional Hospital Board on basic grade Sal scale £460 by £25 to £510 Candidates must h a good honours degree in physics, but prev hospital experience not essential Appointee quired to assist in radium and x-ray proble including rotational therapy, as well as radiotope work —Applications, with names addresses of three referees, to be sent to Director, Cancer Organization, 3 Windsor C cent, Newcastle upon Tyne, 2, as soon as sible

---

READER AND SENIOR LECTURERS Lecturers in Physics —The Dean College of and Science, Baghdad, Iraq

APPOINTMENTS VACAN

RESEARCH PHYSICIST

The British Jute Trade Research Associa has a vacancy for a Physicist to assist in rese into the fundamental principles underlying processing of textile fibres into yarns the w primarily involves classical physics, and a cants should possess a good honours degree commencing salary will be fixed in accorda with the qualifications and experience of person selected and F S S U provision will available

Write, giving full details to the Secretary, British Jute Trade Research Association, noull Road, Kingsway West Dundee

---

PHYSICAL METALLURGIST REQUI for programme of laboratory investigational on alloys in the Research Laboratory of Imp Smelting Corporation Ltd A degree or equiv qualification in metallurgy is required, together at least one year's experience of the practical plication of physical metallurgy work, preferab a research department This is a senior staff pointment, superannuated, and commencing s will be entirely dependent upon individual q fications and experience —Applications to Pe nel Manager, Imperial Smelting Corporation Avonmouth, quoting reference LRM/N

IMPERIAL SMELTING CORPORAT has a vacancy for a Group Leader in Su Chemistry Section of Research Laborator supervise a small group carrying out researc vestigations on the surface chemistry of pigm Applicants should possess an honours degre chemistry and knowledge or experience in su chemistry, colloid chemistry or related fiel Applications, quoting reference GLS/N to sonnel Manager, Imperial Smelting Corpor Ltd , St Andrew's Road Avonmouth Bristo

---

JOHNSON MATTHEY AND CO, require two Graduate Chemists, age 25 to 3 the research laboratories of the Ceramic Div One man is required for investigation into ments, and experience of the paints or p industries would be considered an advantage second man is required for research in the of ceramic colours for the glass and po industries The appointments will be ma the permanent staff and carry full supera tion Salary according to qualifications an perience —Write, giving full particulars of education and experience, to the Res Manager, Johnson Matthey and Co Ltd liam Clowes Street, Burslem Stoke on Tr

MULLARD RESEARCH LABORATORIES invite applications from honours graduates to carry out research and development on the application of new magnetic materials to computors Initially, the work will be concerned with digital storage and information-handling devices incorporating ferrite cores

Postgraduate experience in either computor techniques, transistors or magnetic devices would be an advantage The work calls for a high degree of individual responsibility and there is great scope for initiative and inventiveness Publication of results will be encouraged

Salaries based on qualifications, experience and age, and are in keeping with present-day levels General prospects within the organization are excellent

Applications to

Mr G A Taylor,
Personnel Manager,
Mullard Research Laboratories,
Cross Oak Lane, Salfords,
near Redhill, Surrey,
quoting reference, E R L

A SCIENCE GRADUATE WHO IS IN-
ested in a progressive career in modern manu-
turing is required by a large and growing
mpany with chemical interests During the last
years the company has met its expansion needs
the introduction of graduates of progressive
tlook who wished to make a career in modern
lustry, and who wished to develop in the
nagerial and executive field without losing
ıch with technical matters Most of these
n have read chemistry, but it has appealed also
the engineer or physicist who wished to veer
ay from the purely technical field The initial
sition, after training will be the management
a small process or production department
e position will be clearly defined in both re-
onsibility and authority, and will be preceded
careful training under senior graduate mem-
rs This training will be continued long enough
ensure the position is taken over with confi-
nce Two other positions of a similar nature
ll be available later in the year, and applica-
ns from interested graduates taking finals this
mmer or from men in the Services, will be
nsidered now Upper age limit 27 years Com-
ncing salary £650 to £850, depending upon the
ndidate's background, and this will be paid
ring the training period At the end of train-
full scope will be given for the use of
lity and initiative and progress will be related
ely to merit All senior positions are, without
eption, filled from within the company Strict
nfidence will be observed —Please forward a
ef outline of background, etc, to Box 648,
G Scott and Son, Ltd, 143-147 Regent Street
ndon, W 1

OSEPH LUCAS, LIMITED, HAVE AN IN-
sting vacancy in their research and develop-
nt laboratories which would be suitable for a
ng graduate with honours degree in mathe-
tics or physics The work is largely of a
damental nature, and is concerned with
ustics and mechanical vibrations Previous
ustrial experience is not necessary —Please
ly, giving qualifications age, and any other
vant details, to Personnel Manager, Joseph
as (Electrical), Ltd, Great King Street,
ningham, quoting reference PM/D/59

EQUIRED IMMEDIATELY FOR SERVICE
overseas territories, experienced men, aged 25
35, with good personalities and qualifications
agriculture or agricultural sciences, to act as
hnical Representatives Excellent prospects
good salary according to qualifications, ex-
ience and territory Initial technical and com-
cial training before proceeding overseas —
te (quoting No 1011), stating age, fullest
iculars of qualifications and experience and
ry required, to Personnel Manager, Fisons
Control, Ltd, Bourn, Cambs

UBE INVESTMENTS RESEARCH
oratories require a young scientist for work
olymer research and measurements of proper-
of plastics Excellent prospects for advance-
t as a member of a team engaged on funda-
tal research in a vital new field —Apply,
ng qualifications and experience, to the Secre-
Tube Investments Research Laboratories,
ton Hall, Saffron Walden

RESEARCH AND DEVELOPMENT

Courtaulds, Ltd, invite applications for the following vacancies in their Research and Development Laboratories Bocking Braintree, Essex Graduate Textile Technologist, age 27-32, with industrial experience to work on textile dyeing and finishing Ref No D 61 Graduate Textile Technologist, to work on Research and Development in the field of textile manufacture Ref No D 62 Graduate Chemist, age 33 or less, for work on textile sizing Ref No D 63

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Limited, 16 St Martin's-le-Grand, London, E C 1, quoting the appropriate reference number

CHEMIST

HONOURS GRADUATE

Courtaulds Ltd, has a vacancy in its Textile Research Laboratory at Bocking, Essex, for a Graduate Physical Chemist who is interested in the basic physical problems of textile chemistry and is prepared to contribute original ideas in a developing situation Applicants should possess an honours degree and have had practical experience of research methods Age 25 to 33

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds, Ltd, 16 St Martin's-le-Grand London, E C 1, quoting the reference number D 64

DISTILLERS COMPANY LIMITED

A vacancy has arisen in the Industrial Group Secretariat of the Company for an Assistant (male or female) to take charge of the recording and distribution of technical information Duties will include reading abstracting and circulating technical journals, and devising suitable filing systems for technico/chemical information Applicants should be between 30-50 years of age, and should possess a degree in chemistry or economics A knowledge of French and German, together with experience of abstracting from technical literature would be an advantage

Apply Staff Manager, The Distillers Co, Ltd, 21 St James's Square London, S W 1 Ref 4/55

A SPONSORED RESEARCH ORGANIZATion requires young Organic Chemists, male or female with honours degree or equivalent, for research and development work Recently graduated applicants would find this an interesting opening to industrial research Applications are also invited from organic chemists for a more senior position —Full particulars, in confidence to J A Radley, Industrial Research and Development Laboratories Elgar Road, Reading

RESEARCH CHEMIST THE BRITISH Drug Houses, Ltd, have a vacancy in their Chemical Research Laboratories for a young woman graduate interested in steroid chemistry Previous experience desirable, but not essential —Write, giving details of studies, experience, if any, and age, to Staff Manager, Graham Street, City Road, N 1

A GRADUATE IS REQUIRED FOR BASIC and applied research on the machining and cold forming of metals A good degree (or equivalent qualification) in engineering science or metallurgy is required There are good prospects for advancement Commencing salary commensurate with qualifications and experience Pension scheme —Send full details, including age, experience, qualifications and present salary in confidence to Box 649 T G Scott and Son Ltd 143-147 Regent Street, London, W 1

APPLICATIONS ARE INVITED FROM recently qualified chemists for an interesting and progressive post in a cereal laboratory The work will involve non-routine analysis and research Applicants should be in the 20-25 age group Five-day week, and pension scheme in operation —Write, giving full particulars of academic qualifications and experience to Personnel Manager (L), Quaker Oats Limited, Bridge Road, Southall Middlesex

PHILIPS BALHAM WORKS, LTD 45 Nightingale Lane, S W 12, requires Graduate in Electrical Engineering or Physics preferably with experience in electronics, for development of nucleonic instruments Permanent appointment with excellent prospects —Applications should be addressed to the Personnel Officer at the above address

THE EDISON SWAN ELECTRIC CO, Ltd, Cosmos Works, Brimsdown, Enfield, Middlesex, has vacancies in its Research and Development Departments for

1. Development Engineers for work on design and development of thermionic valves
2. Technical Assistants for work in connection with design and development of thermionic valves
3. Mechanical Engineers interested in the problems of mass production associated with thermionic valves

These vacancies are the result of a rapid expansion in the Company's activities The positions are progressive and carry the advantages of a pension scheme

Applicants for vacancies (1) should have an engineering or physics degree but applications from candidates with H N C or equivalent will be considered

Applicants for vacancies (2) and (3) should have ordinary N C or H N C or Inter B Sc or equivalent

The starting salary will be in accordance with the qualifications, experience and age of the applicants

Applications should be in writing and will be treated with the strictest confidence

Apply to the Personnel Superintendent

RESEARCH ENGINEERS HONOURS graduates preferably with some postgraduate or industrial research experience, capable of planning and controlling research work on a wide range of mechanical engineering problems including materials structures, mechanisms and heat transfer Wide scope and good prospects for men with initiative Age 25 to 30 approximately —Applicants should write to Manager, Research Department, Metropolitan-Vickers Electrical Co Ltd, Trafford Park, Manchester, 17, giving a statement of their age, qualifications and experience and suitable references

ARTHUR GUINNESS, SON & CO (DUBlin) Ltd have a vacancy for a Chemist in their Brewing Research Laboratory, Dublin, to work on general analytical and brewing research problems Candidates should possess a good honours degree in chemistry, and some postgraduate experience Salary according to qualifications and experience There is a non-contributory pension scheme, and other benefits — Applications, giving full details of qualifications and experience, should be addressed to the Chief Chemist, Arthur Guinness Son & Co (Dublin), Ltd, St James's Gate, Dublin

ARTHUR GUINNESS, SON & CO (DUBlin) Ltd require a Chemist or Biochemist for their Brewing Research Laboratory in Dublin The post will be a responsible one and will offer ample scope and prospects to one interested in biochemical research work Candidates should be under thirty years of age and possess a good honours degree in chemistry or biochemistry and postgraduate experience in research work Knowledge of enzymology would be an advantage A good salary will be offered and there is a non-contributory pension scheme, and other benefits —Applications, giving full details of qualifications and experience should be addressed to the Chief Chemist, Arthur Guinness Son & Co (Dublin) Ltd, St James's Gate Dublin

ENGLISH CLAYS LOVERING POCHIN & Co Ltd St Austell, Cornwall, have vacancies in the Research Department for (1) an Inorganic Chemist with postgraduate experience (2) a Graduate Physical Chemist —Application in confidence to the Research Manager

SENIOR AND JUNIOR RESEARCH PHYsicists, preferably with university or industrial research experience are required to undertake basic research work of thermionic emission and related aspects of surface physics Wide scope and good prospects for men with initiative — Applicants should write to the Manager, Research Department, Metropolitan-Vickers Electrical Co Ltd, Trafford Park Manchester, 17, giving particulars of their age, qualifications and experience and suitable references

LADY CHEMIST, GRADUATE OR H N C, required for analysis of electroplating and allied solutions —Apply, Electro-Chemical Engineering Co, Ltd, 161 Queens Road, Weybridge, Surrey

TECHNICAL LIBRARIAN

WOMAN

Courtaulds Limited require a technical librarian (woman) for a new research laboratory at Coventry Candidates should have a knowledge of chemistry to degree standard and previous experience in an industrial technical library

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds Limited, 16 St Martin's-le-Grand, London, E C 1, quoting the reference number D 60

BAKELITE LIMITED HAVE VACANCIES at their Aycliffe (Co Durham) works for two young qualified chemists and a young chemical engineer Applicants should have a B Sc degree or equivalent and some industrial experience The work concerns chemical and chemical engineering investigation into problems arising in the manufacture of P V C resins and compounds, and the manufacture of products based upon P V C resins Salaries will be in the range of £650 to £850 per annum in accordance with age and experience —Applications should be addressed to The Personnel Manager, Bakelite Limited, 12 Hobart Place, London, S W 1

GLASS / CERAMIC / VITREOUS ENAMELling Technologists, preferably university graduates, required for research and development work on vitreous enamels at laboratories situated in Warrington Candidates should have had some industrial experience in one of the ceramic fields, and be less than 35 years of age —Replies should be addressed to Radiation Ceramics Research Department, Richmonds Gas Stove Company, Ltd Grappenhall Works Warrington

---

ROWNTREE & CO , LTD , INVITE APPLICATIONS for three senior appointments in the fields of biochemistry, physical chemistry and physics on the staff of a new Research Unit at York, the erection of which is now nearing completion The men appointed should have high professional attainments in their respective fields, and in particular should have initiative and the ability to handle their problems constructively They will be expected to work co-operatively on the various projects under investigation , the problems will be related to the Company's products and, while not academic in character, they will nevertheless, be of a fundamental nature It is hoped that ultimately one of these men will be appointed to head the Unit Men of exceptional calibre are being sought, and the salary will be commensurate with these qualifications Appointments will qualify for participation in the Company's Pension Scheme, under which pensions equivalent to two-thirds of salary are achievable —Letters of application should give, in confidence full details of the applicant's age, training and career, and should be addressed to the Staff Officer (Men A), Rowntree & Co , Ltd The Cocoa Works, York

---

THE BRITISH BOOT, SHOE AND ALLIED Trades Research Association requires two young physicists Post No 1 For work on physical properties of shoes and shoe materials (e g , moisture transmission and sorption , elasticity and plasticity) and applications to (a) foot comfort problems (in collaboration with a physiologist), and (b) basic processes of the industry (e g , lasting) Qualifications At least two years' research experience, with proved ability in experimental and theoretical work Post No 2 For practical research and development work on (a) footwear production and wear problems, and (b) shoe materials Recent graduates considered, but some laboratory experience (industrial or other) will justify higher starting salary Both posts offer good prospects in status and salary (no fixed ceiling) F S S U —Applications to H Bradley, C B E , Director of Research Satra House, Rockingham Road, Kettering, Northants

---

GRADUATE CHEMIST, METALLURGIST or Chemical Engineer required to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel —Apply, Electro-Chemical Engineering Co , Ltd , 161 Queens Road, Weybridge, Surrey

---

CHEMISTS OR PHYSICAL CHEMISTS, with honours degree or equivalent required for fundamental investigations on the combustion of fuels, with particular reference to corrosion problems Initial salary according to qualifications and experience in range £500 to £740, or £800 to £900 Pension scheme —Apply in writing to Assistant Secretary Ref B 10, B C U R A , Randalls Road Leatherhead

---

EDITORIAL ASSISTANT REQUIRED FOR metallurgical monthly in London Training in pure or applied science desirable —Full details to Box 647 T G Scott and Son, Ltd 143-147 Regent Street London W 1

THE EDISON SWAN ELECTRIC CO , Ltd , Cosmos Works, Brimsdown, Enfield, Middlesex, has vacancies in its Research and Development Laboratories for

1 Circuit Development and Application Engineers for colour television investigations

2 Circuit Development and Application Engineers for black and white television development work

3 Engineers for development work on television and F M amplifier problems Previous experience in V H F or F M required

4 Cathode Ray Tube Development Engineers for development work on colour and black and white tubes Previous experience on cathode ray tube development or design required

5 Application Engineers for work in connection with customer problems on television, radio and F M

6 Engineer for design of test equipment for colour black and white television and allied development work

7 Engineers for circuit development and application work on transistors

The above applicants should have a good engineering or physics degree or equivalent, but vacancies also exist for candidates with H N C or equivalent qualifications

The vacancies are a result of a large expansion in the Company's activities

Good salaries will be paid to suitable applicants, and the positions are progressive and carry the advantages of a pension scheme

The starting salary will depend on the qualifications, experience and age of the applicants

Applications in writing, which will be treated with the strictest confidence, should be sent to the Personnel Superintendent

---

MECHANICAL AND CHEMICAL ENGINEERS

Courtaulds, Limited Chemicals Division, requires two graduate Mechanical Engineers and one Chemical Engineer for investigational and development work near Manchester The work is of an original nature in connexion with the development of chemical plants and processes for which a real interest in, and potential talent for, engineering development work as applied to large-scale chemical plant is of paramount importance The Mechanical Engineers must have served an apprenticeship for at least two years and all candidates must have had practical works experience Honours degree men preferred Age 25 to 35

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds, Limited, 16 St Martin's-le-Grand, London E C 1, quoting the reference number H8 for Mechanical Engineers and H 9 for the Chemical Engineer

---

ASSISTANT WITH TECHNICAL QUALIfications required by Metropolitan-Vickers Electrical Co Ltd , Trafford Park, Manchester, 17, to train as Industrial Information Officer Experience of this type of work is not essential Salary will depend on qualifications and experience and will be progressive —Write giving full particulars including age, sex nationality education and experience to Personnel Manager marking envelope " H 2 "

ABSTRACTOR REQUIRED FOR ENGINeering and physics subjects by Metropolitan-Vickers Electrical Co Ltd Trafford Park Manchester, 17 Progressive opportunities for one who has ability for concise expression, is interested in new developments and in writing up technical matter Engineering experience would be an advantage initially, but experience in abstracting not essential —Apply in writing to Personnel Manager, giving details of technical qualifications experience, if any, and present salary Mark envelope " F 1 "

MAY & BAKER LTD , DAGENHAM, Essex, have a vacancy for a young graduate in their Biological Control Department The post involves mainly biological standardization of chemotherapeutic substances —Apply initially in writing, stating age and qualifications, to the Personnel Officer, quoting reference No 69

UNICAM INSTRUMENTS, LTD.

Applications are invited from electron
engineers for positions in the develo
ment and inspection departments of Unicam I
struments of Cambridge This company is e
gaged in the manufacture of important instr
ments, combining original optical and electron
design, which are much in demand for academ
and industrial research and process control t
world over Good salaries according to quali
cations will be paid —Applicants should send f
details of age, education and experience to t
Personnel Manager, Unicam Instruments Lt
Arbury Works Cambridge

PHYSICIST / MATHEMATICIAN TAYLO
Taylor & Hobson, Ltd , require a man
specialize in the design and development
precision optical instruments He must be
skilled optical designer capable of tackling a w
range of problems, and will work in close c
operation with the Mechanical Design Depa
ment A starting salary of not less than £8
per annum will be paid to a suitable candida
—Apply to Development Director, Stought
Street Works Leicester

PHILIPS RESEARCH LABORATORIES R
quire a Graduate Chemist or Physical Chemist
investigational work on ceramic materials as us
in the electronics industry Age not over
years Interesting and varied work in mode
laboratory situated on southern outskirts of L
don Salary £600 upwards, according to a
ability and experience —Please apply in writing
the Personnel Officer, Philips Electrical Industri
Ltd , New Road, Mitcham Junction Surrey, qu
ing the reference M R 145

THE BRITISH PETROLEUM COMPA
Limited has immediate vacancies for Chem
Chemical Engineers and Mechanical Engineers
work in their United Kingdom Refineries and
their Research Station at Sunbury-on-Tham
Applications are invited from men with first-
second-class honours degrees or equivalent qua
cations and who have fulfilled National Serv
obligations Previous industrial experience de
able but not essential Age preferably not ab
33 Salaries within the range £600 to £1,
according to qualifications and experience Ex
lent working conditions Non-contributory p
sion scheme —Write, giving full details, quot
H 3297, to Box 7302, c/o 191 Gresham Hou
E C 2

WANTED FOR WORKS ASSAY LABOR
tory Eastern Seaboard, U S A Analyt
Chemist Applicants must hold university deg
or equivalent qualification and have had four
more years' experience as works chemist
work will be mainly inorganic analyses and ap
cants must be capable of working out ra
methods for the determination of the lesser kn
metals Salary according to age and experienc
Write, giving full particulars of age, educa
and experience, to Box S 215, c / o Streets,
Old Broad Street E C 2

ASSISTANT RESEARCH INVESTIGAT
required by Technical Organization of Gla
Metal Co Ltd for investigation into
materials for plain bearings Degree in metall
or metallurgical chemistry, or L I M essen
Position offers scope for keen young man cap
of developing ideas and of working mainly
his own initiative Men graduating in June
sidered Starting salary £600 to £750 per ann
—Applications to Personnel Manager, Ea
Road, Alperton Middlesex

APLIN AND BARRETT LTD , YEOVIL,
quire a Senior Laboratory Steward for their
tral Laboratories The Department incl
routine and research laboratories carrying
chemical, biochemical radiochemical and
teriological work Some glass working ex
ence would be an advantage Salary accor
to age and experience —Applications to Adm
trative Officer Technical Department Aplin
Barrett, Ltd , Newton Road Yeovil Somers

TECHNICAL SALESMAN, EXPERIEN
and qualified to develop chemical sales to
resin manufacturers Interesting post, good
pects Pension and profits-sharing schem
Write full details age, qualifications exper
to date, and salary required, to Ref TSP
8336 c / o Charles Barker & Sons, Ltd
Budge Row London, E C 4

CHEMISTS PHYSICO-CHEMICAL B
interested in design, development and sellin
equipment for laboratory use —State expe
and salary required, to Technical Director
652, T G Scott and Son, Ltd , 143-147 R
Street, London W 1

ELECTRONICS AND PHYSICS

SISTANTS required for LABORATORY
ORK of wide interest in ELECTRONICS or
YSICS RESEARCH

Excellent OPPORTUNITIES for FURTHER
UCATION and ADVANCEMENT

ENTHUSIASM major requirement

Laboratory in pleasant rural surroundings near
ading

Apply, in writing, with full particulars of any
vious experience and training, to Personnel
icer, Research Laboratory, ASSOCIATED
ECTRICAL INDUSTRIES, Ltd Aldermaston
urt ALDERMASTON, Berks

ANALYTICAL CHEMIST

ritish Insulated Callender's Cables Ltd re-
ire an Analytical Chemist with some experi-
e in the field of corrosion, for work in their
rosion Research Laboratory, Kirkby, near
erpool The minimum qualifications required
an honours B Sc degree in chemistry or the
sociateship of the Royal Institute of Chemis-

Salary will be in accordance with age quali-
itions and experience

Applications should be addressed to the under-
ned quoting reference number P/70/55

THE STAFF OFFICER, B I C C LTD ,
Prescot, Lancs

HEMISTS ARE REQUIRED FOR THE
stics Division of Thomas De La Rue and
mpany Limited The vacancies are caused by
continuous expansion of the Company's
ivities in the plastics field and offer a wide
erience in this industry Applicants should
ssess a university degree, high national certi-
ate, or A R I C in chemistry or technology
d must show evidence of a wide field of inter-
s The positions may involve liaison with
stomers and a pleasant personality will there-
e be considered important Successful appli-
nts will be given adequate training and will
n be responsible for process control of plastics
nufacture Promotion will be rapid for those
wing keenness and ability The starting
ary will depend upon qualifications and ex-
ience, but will in no case be less than £600
annum—Apply, giving brief details of
demic and industrial experience to Personnel
nager, Thomas De La Rue & Co , Ltd West
rton North Shields Northumberland

METALLURGIST OR CHEMIST WITH UNI-
sity degree or equivalent required in modern
tallurgical research laboratory for investigational
rk on problems associated with metal arc weld-
Some experience in research or industry
irable, a knowledge of arc welding an advan-
e but not essential Excellent salary and pros-
ts—Applications, giving full details to Re-
rch Manager, Ref M , Murex Welding Pro-
ses Ltd , Waltham Cross, Herts

RITISH INSULATED CALLENDER'S
bles Ltd , require Chemists at their Helsby
rks near Chester, preferably graduates with
ne industrial experience for development and
lytical work on Thermoplastic Cable Com-
unds—Applications should be submitted in
iting, quoting reference No H/73/55 to Staff
icer, B I C C Ltd , Prescot, Lancs

WELL QUALIFIED GRADUATE CHEMIST
Physicist, preferably with experience in the
stics industry, wanted for development work
the rapidly expanding field of fibreglass re-
orced plastics Salary according to age and
erience, with good conditions of employment
promotion prospects—Applications to the
chnical Director, Fibreglass, Limited, Raven-
d Works, St Helens Lancashire (a subsidiary
Pilkington Brothers, Limited)

Advertisers please note You must add "Apply Employment Exchange" unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

---

CHIEF CHEMIST REQUIRED BY FIRM specializing in the rare metals to supervise both routine and research laboratories Ph D or equivalent degree with some industrial experience Commencing salary £1,500 per annum. Contributory pension scheme—Box 636 T G Scott and Son, Ltd , 143-147 Regent Street, London W 1

IMPERIAL CHEMICAL INDUSTRIES, LTD Lime Division has vacancies for Research Chemists (age range 26-35) Candidates should have a Ph D , M Sc , or at least an honours degree in physical and inorganic chemistry—Apply, giving full particulars, to the Division Staff Officer, Royal Exchange, Buxton

---

BOOTS PURE DRUG CO LTD HAVE A vacancy in the Pharmacology Division of the Research Department for a young graduate, preferably with some research experience The successful applicant will be engaged in pharmacological and toxicological investigations Salary in accordance with qualifications and experience—Applications to Personnel Manager Station Street Nottingham

---

THE SHELL PETROLEUM COMPANY, Limited has following openings at their Research Centre, Thornton-le-Moors, Cheshire for (A) Organic Chemists, positions involving applicational work on the Company's products, and will concern studies in the fields of organic synthesis, hydrocarbon analysis or general oil chemistry Candidates should possess good honours degree or equivalent (B) Physical or Organic Chemists, preferably with postgraduate research experience and an interest in mass spectrometry The work is concerned with application of a mass spectrometer to research on gaseous, volatile and higher boiling hydrocarbons A working knowledge of electronics and mathematics, including the use of calculating machines, is essential, and general interest in the use of fuels and lubricants would be an additional advantage Starting salary according to qualifications and experience Attractive pension benefits—Apply in writing giving age, full details of experience and qualifications also whether applying for (A) or (B) to Staff Department R/2, Shell Petroleum Company, Limited, St Helen's Court, London E C 3

APPLICATIONS ARE INVITED FROM young Physicists possessing honours degree for work on the development of transistors Post-graduate work on semi-conductors and solid state physics would be an added qualification Laboratories in ideal country surroundings—Applications to Personnel Manager, Standard Telephones and Cables, Ltd , Ilminster

APPOINTMENTS WANTED

BACTERIOLOGIST, 11 YEARS' TECHNICAL and administrative experience, desires post in India preferably Bombay—Box 650 T G Scott and Son, Ltd 143-147 Regent St , London, W 1

GRANTS & SCHOLARSHIPS

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

LONDON, S W 7

ROYAL DUTCH SHELL STUDENTSHIP IN GEOPHYSICS

This studentship is open to honours graduates in physics or geology (with mathematics and physics at intermediate level) for a two-year course from October, 1955, in Geophysical Prospecting applied to the search for oil Value £430 per annum less fees £60 per annum

Applications must be received before June 1 1955 Further particulars from Registrar, Imperial College S W 7

UNIVERSITY OF CAMBRIDGE

ESSO STUDENTSHIP IN CHEMICAL ENGINEERING

The Managers of the Esso Fund invite applications for an Esso Studentship to be tenable in the Department of Chemical Engineering of the University of Cambridge Applicants should be persons domiciled in Great Britain or Northern Ireland who hold or expect to hold a university degree with high honours in chemical engineering or in some other branch of engineering or chemistry The Studentship will be tenable for two years from October 1, 1955, and it will be necessary for the student to become a member of the University of Cambridge before the end of the Michaelmas Term, 1955, and to remain a member of it during his tenure of the Studentship It will be the duty of the student to devote himself to full-time study and training for research in chemical engineering, under such conditions as the Managers may determine The value of the Studentship will be £350 a year plus approved fees

Forms of application may be obtained from the Secretary Department of Chemical Engineering, Tennis Court Road, Cambridge, and should be completed and returned so as to reach him not later than April 30, 1955

ROYAL HOLLOWAY COLLEGE

UNIVERSITY OF LONDON

Tutorial Research Studentships in English and Mathematics (pure or applied) are offered for the session 1955-6, renewable for a second year A Studentship is intended to enable the holder, while gaining some experience of university teaching, to work for a higher degree of the University of London or some other university Value £300 a year, or £150 with board and residence

Particulars may be obtained from the Principal, Royal Holloway College, Englefield Green, Surrey, to whom applications should be sent as soon as possible and not later than March 14, 1955

THE ROYAL SOCIETY

GOVERNMENT GRANT FOR SCIENTIFIC INVESTIGATIONS

Applications for grants from the first allotment of the Government Grant for Scientific Investigations for the year 1955 should be made as soon as possible on forms of application to be obtained from the Assistant Secretary of the Royal Society, Burlington House, London, W 1 No application can be considered which is received later than March 31, 1955

Applicants must be of British nationality resident in Great Britain or Northern Ireland Grants may be made for purposes in connection with the promotion and support of research in pure science other than for personal maintenance or payment of stipends , for the assistance of scientific expeditions and collections , but not in aid of scientific publications

FOR SALE AND WANTED

CORNEAL AND CONTACT LENSES EASY payments arranged if desired—For details and free booklet write David Blackstone, Ltd , Dept 235, Triumph House, 189 Regent Street, London, W 1 Tel Regent 3516-7 Consulting Rooms in Leeds, York, Leicester, Middlesbrough, Newcastle etc

---

CAMBRIDGE MAGNETIC OXYGEN METER for sale For details write Sherrington School of Physiology, St Thomas's Hospital, London, S E 1

FOR SALE, CAMBRIDGE BENCH TYPE *p*H Meter, as new recently overhauled and checked by makers No electrodes or battery Best offer over £35—Box 651, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1

MISCELLANEOUS

ELECTRONICS APPLIED TO INDUSTRY Learn the basic principles and applications with our modern self-study course Experimental work included if required—Free Brochure from E M I Institutes Dept N 56, London, W 4 (Associated with H M V)

• Individually Tested and Guaranteed •
(A E R E Harwell approved)
HIGH VACUUM STOPCOCKS
New Catalogue on request to
G. SPRINGHAM & CO. Harlow New Town
"The Stopcock People" HARLOW 24108

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE
FROM LIVER OR YEAST
and other SIGMA brand products are now available
Ask for list SIGMA 8
GEORGE T. GURR LTD.
136-138 NEW KINGS RD, LONDON, S W 6
The Microscopical Stain People

NIPA·ESTERS

PARAHYDROXYBENZOATES GALLATES

The well-known & reliable neutral preservatives, antiseptics, antioxidants for all scientific and industrial purposes

NIPAGIN
NIPASOL
NIPACOMBIN
NIPABENZYL
PROGALLIN
PHENOXETOL

NIPA LABORATORIES LTD., TREFOREST TRADING ESTATE, Near CARDIFF
Telephone: Treforest 2128/9
Sole Distributors for the U K.
P. SAMUELSON & CO, ROMAN WALL HOUSE, I, CRUTCHED FRIARS, LONDON, E C 3. *Tel· Royal* 2117/8

HIGH SPEED VIBRATION MILL (100 *C P S*), ideal for KBr disk technique and other fine and fast grinding

ROTATING ELECTRODE (*graphite disk*) **SPARK UNIT** for the study of lubricating oils, other liquids and powders

Descriptive literature on application

RESEARCH & INDUSTRIAL INSTRUMENTS CO.
1 Laycock Street, Islington, London, N 1. ARChway 5488

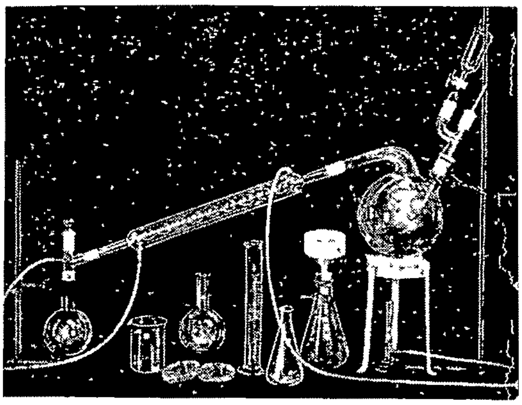
PRESS for making KBr and KCl DISKS
as used in I-R and U-V solid state study

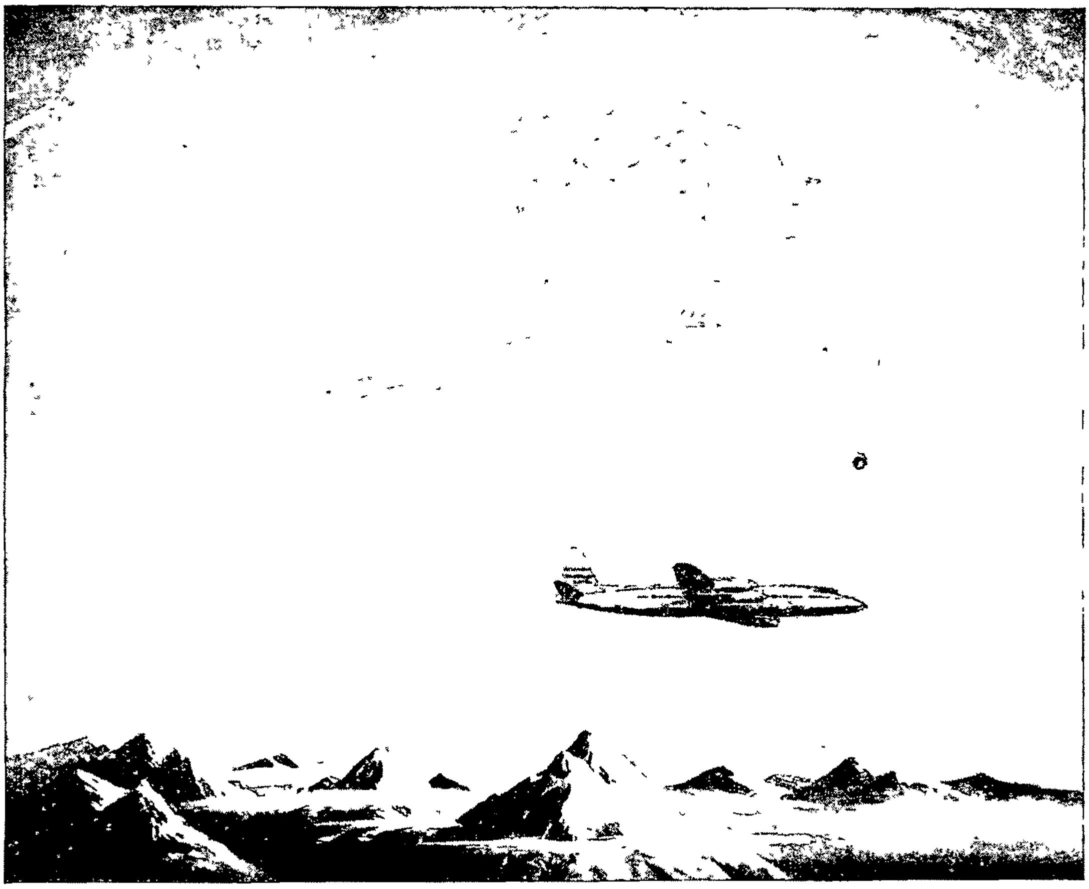
INFRA-RED CELLS
Variable path-length cells for liquids
Fixed path-length cells for liquids and gases
(Made by Research & Industrial Instruments Co)
Catalogue CH388/N2 free on application from
HILGER & WATTS LTD.
98 St. Pancras Way, London, N.W.1

Glass apparatus to your specification

Your general Laboratory Glassware and Requisites

THE SCIENTIFIC GLASSBLOWING CO. LTD.
95, GRAY'S INN ROAD, LONDON, W.C.1
Telephone · HOLBORN 4228





"The Tiger that lurks in the skies"
. . . will FLUOROCARBONS be the answer?

"Fire", the tiger of the skyways has not yet been banished from aircraft — and scientists the world over are still seeking a complete solution to this menace Fluorocarbons may well provide the answer and would seem to offer the highest possibilities of evolving completely fire-proof aircraft Investigations have shown that Fluorocarbon liquids can replace the inflammable fluids at present used in hydraulic control systems and de-icing equipment Lubricants too can be made of Fluorocarbons — in addition, the application of Fluorocarbons to high speed bearings and inflammable paints is well within the bounds of possibility

ANHYDROUS HYDROFLUORIC ACID HYDROFLUORIC ACID
BORON TRIFLUORIDE · BENZOTRIFLUORIDE FLUOSULPHONIC ACID

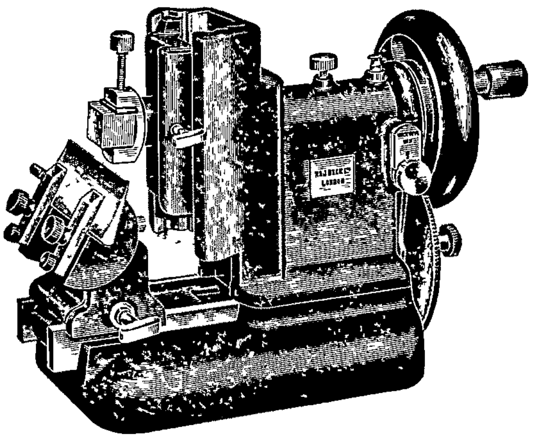
The above compounds are of great value in the manufacture of fluorinated materials and are available in commercial quantities Industrial applications include catalysts, lubricants, plastics and specialised welding

Should you have any problems or theories on these or any other applications please consult us

IMPERIAL SMELTING
U.K. MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

PIONEERS IN FLUORINE DEVELOPMENT

IMPERIAL SMELTING CORPORATION (SALES) LTD 37 DOVER STREET LONDON W1

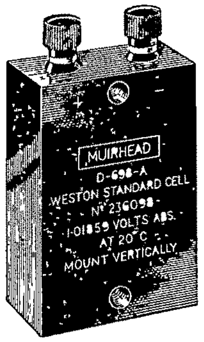


BECK

ROTARY MICROTOME

Descriptive leaflet forwarded on application

R. & J. BECK LTD.
69/71 MORTIMER ST, LONDON, W 1



A New Standard Cell by MUIRHEAD

£3.0.0
(Post free in U K)

D-698 WESTON STANDARD CELL

This new cell combines the robustness and small size of our D-550 Miniature Standard Cell with a high capacity previously only obtainable in larger and more expensive types such as our D-402

Whether you require a standard of E M F for an industrial application or for laboratory use, this new cell will meet your needs and give many years of reliable service

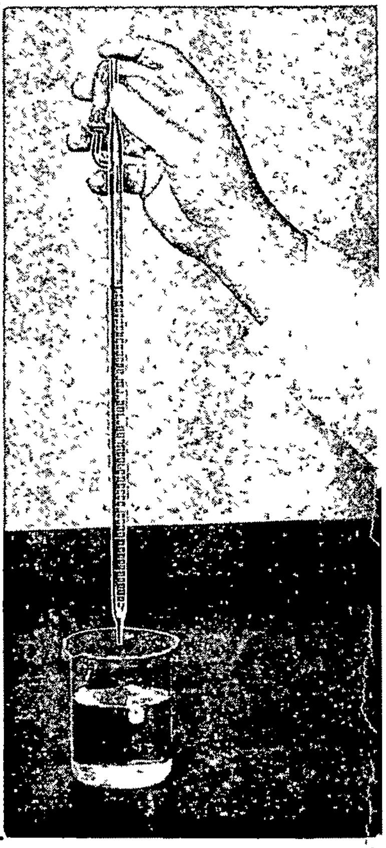
SPECIFICATION

E M F	1 01859V+110µV −90µV at 20°C
Temperature coefficient	− 0 00004 per °C
Discharge rate	Up to 20µA for short periods
Internal resistance	600 ohms
Overall dimensions	1 15/16" x 1" x 3 3/8
Weight	4 oz

Our D-550-A and D-402 Weston Standard Cells are still available

WRITE UNDER YOUR BUSINESS LETTERHEAD FOR PUBLICATION 5716

MUIRHEAD & CO. LIMITED BECKENHAM KENT ENGLAND
PRECISION ELECTRICAL INSTRUMENTS 147



For use with radioactive or other dangerous liquids . . .

Technico REGD **PIPETTES**
Swallow Pattern

The simplest safety pipette yet designed These pipettes are filled by means of a rubber teat and then adjusted and used in the normal way. They are robust, easy to clean or sterilise, simple and accurate to use and inexpensive The graduated portion conforms to the Trade B requirements of BS 700

Type 1 For delivery from top zero mark to a graduation mark

Type 2 For delivery from a graduation mark down to jet

1, 2 and 5 ml capacity

Full particulars sent on application

A. GALLENKAMP & Co., Ltd.
17-29 SUN STREET, LONDON, E.C.2

Printed in Great Britain by Fisher, Knight & Co , Ltd , The Gainsborough Press, St Albans and published by Macmillan & Co , Limited, at St Martin's Street, London, W C 2, and St Martin's Press, Inc , 103 Park Avenue, New York 17, N Y , U S A —Saturday, February 19, 1955

"NATURE", FEBRUARY 26, 1955

SUPPLEMENTS: RECENT SCIENTIFIC and TECHNICAL BOOKS
INDEX to VOLUME 174

NATURE

'To the solid ground
Of nature trusts the Mind that builds for aye'—Wordsworth

Vol 175, No 4452 SATURDAY, FEBRUARY 26, 1955 Three Shillings

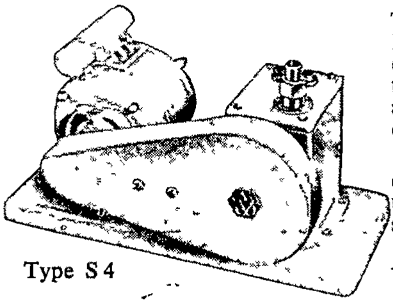
THE Newton

LONG WORKING DISTANCE ATTACHMENT

provides a working distance of 12 8 mm between object glass and specimen when fitted to a standard microscope in conjunction with a conventional 4 or 8 mm objective.

A further important feature is that the use of this attachment eliminates image reversal and thus further facilitates examination and manipulation of specimens

Write for further details to Metropolitan-Vickers Electrical Co, Ltd, Trafford Park, Manchester, 17
Member of the A E I Group of Companies N/A 101



METROVAC PUMPS

Typical of the Metrovac range of rotary pumps, the Type S 4 has a displacement of 0 4 litres/sec.

Other models cover the range up to 33 litres/sec.

Please write for full details

Type S 4

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

Member of the A E I group of companies

VACUUM PUMPS N/P402

Meteorological Instruments

ANEMOMETERS • BAROMETERS • HYGROMETERS
RAIN GAUGES • THERMOMETERS
SUNSHINE RECORDERS, etc.

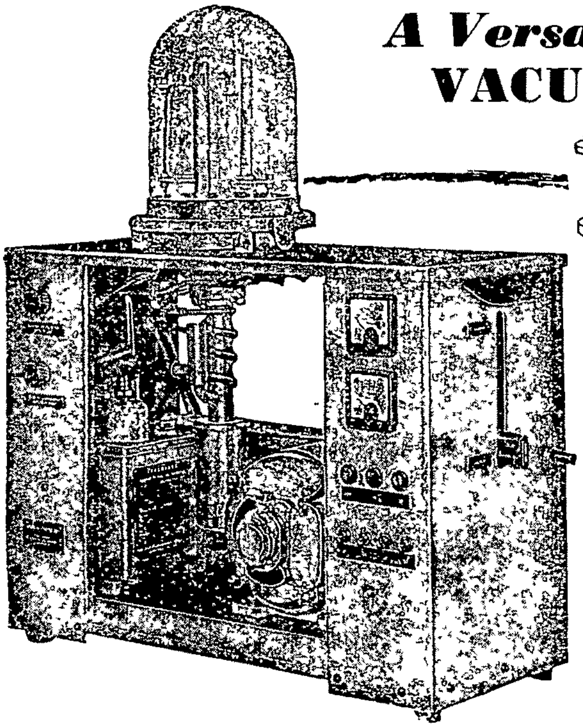
Negretti & Zambra Ltd., REGent 3406
122 Regent Street, London, W.1 Telegrams: Negretti, Piccy., London

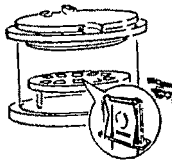
Manufacturers of instruments for the indication, recording and controlling of temperature, pressure, liquid level, volume, specific gravity, humidity, etc. Meteorological and Aircraft Instruments.

BRANCHES: Birmingham · Cardiff · Glasgow · Leeds · Manchester · Nottingham

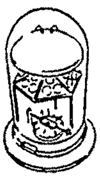
Technical Service available in most countries

A *Versatile Research Tool fo*
VACUUM 'METALLIZING'

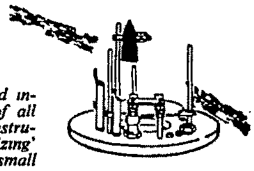




Evaporation or sputtering of H F quartz crystals with frequency control



Anti-reflection and interference films of all types for optical instruments 'Metallizing' plastic mouldings, small mirrors, etc



Shadow-casting for electro and visual microscopy Preparing thin films fo electron diffraction investi gation.

If you require to deposit thin metallic films fo experimental, decorative or functional purposes or wish to try out new production ideas, solv production snags and problems under the sam working conditions as the industrial plant, thi miniature pre-production research unit is th perfect answer—it REALLY is an extremely versa tile high vacuum tool.

LET US SEND YOU FULL PARTICULAR

W. EDWARDS
& CO (LONDON) LTD
MANOR ROYAL · CRAWLEY · SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

Instruments for CASELLA LONDON *Science & Industry*

Instruments for

INDICATING, MEASURING or RECORDIN
HUMIDITY

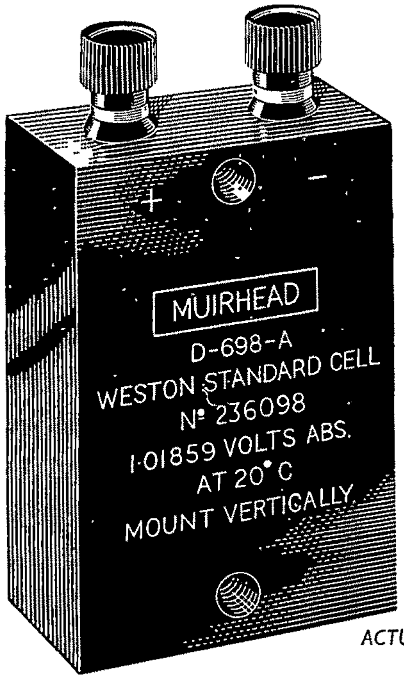
✚

We pride ourselves on the precision, quality and finish of our products, and shall be pleased to send you details if you will write and indicate your interest.

Casella ESTABLISHED 1810

C. F. CASELLA & CO LTD. REGENT HOUSE FITZROY SQ LONDON W 1 Telephone ★ EUSton 394

Member Scientific Instrument Manufacturers' Association of Great Britain



ACTUAL SIZE

A New Standard Cell by MUIRHEAD

£3.0.0

Post free in U.K.

D-698 WESTON STANDARD CELL

This new cell combines the robustness and small size of our D-550 Miniature Standard Cell with a high capacity previously only obtainable in larger and more expensive types such as our D-402.

Whether you require a standard of E M F. for an industrial application or for laboratory use, this new cell will meet your needs and give many years of reliable service.

SPECIFICATION

E.M.F.	$1.01859\text{V} + 110\mu\text{V} - 90\mu\text{V}$ at 20°C.
Temperature coefficient	—0 00004 per °C.
Discharge rate	Up to $20\mu\text{A}$ for short periods
Internal resistance	600 ohms
Overall dimensions	$1\frac{15}{16}'' \times 1'' \times 3\frac{3}{8}''$
Weight	4 oz

Our D-550-A and D-402 Weston Standard Cells are still available

MUIRHEAD

PRECISION ELECTRICAL INSTRUMENTS

WRITE UNDER YOUR BUSINESS
LETTERHEAD FOR
PUBLICATION 5716

138

UIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

Wherever you need distilled water — in laboratory, factory or shop — you can use 'Deminrolit Water' with equal results The Portable 'Deminrolit' plant operates by ion exchange and delivers water substantially free from dissolved solids. Running costs are measured in pence instead of in pounds, and you can thus use distilled quality water for many purposes where the cost of distillation would prove prohibitive

Please write for Technical Publication No 62 which gives full details.

HIRE SERVICE

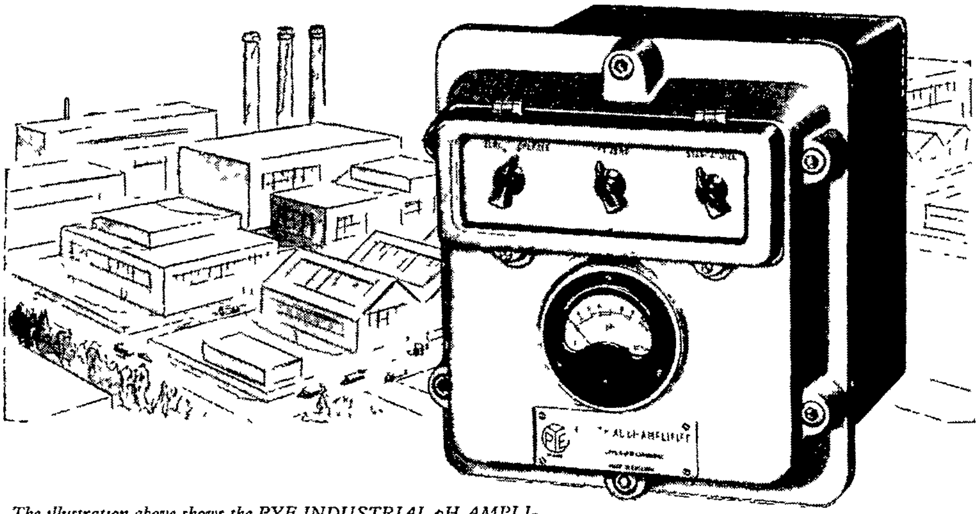
Why not try demineralised water in your industry? You can do so easily and cheaply by hiring from us, at a nominal rental for a trial period, the latest Mark II Model Portable 'Deminrolit' Plant Details of this service will gladly be supplied on request.

PERMUTIT 'DEMINROLIT'

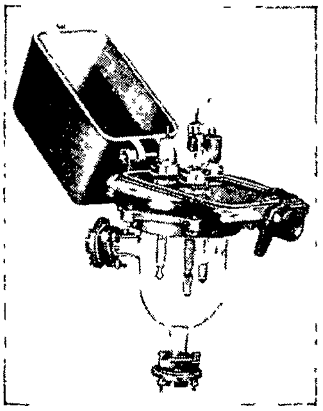
THE PERMUTIT COMPANY LIMITED

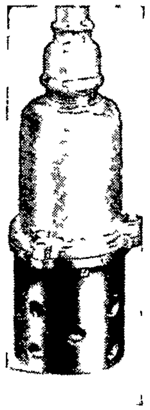
(Dept. V.H. 173), Permutit House, Gunnersbury Avenue, London, W.4. Telephone : CHIswick 6431

INDUSTRIAL pH AMPLIFIER



The illustration above shows the PYE INDUSTRIAL pH AMPLIFIER Cat No 11400, which is built into a flame-proof case, constructed for easy servicing and designed for the continuous measurement of pH values It will drive controllers, recorders, remote indicators and alarm-relays Below on the left is illustrated the Continuous Flow Electrode Assembly, Cat No 11420 and on the right the Immersion Type Electrode Assembly, Cat No 11405 May we send you details of these instruments ?





IN every industry where water or chemical solutions are used, money can be saved and efficiency can be increased through effective pH measurement and control The exact measurement of acidity and alkalinity will readily provide the key for methods of eliminating waste, reducing maintenance and corrosion, developing new products and improving product quality at the lowest possible cost

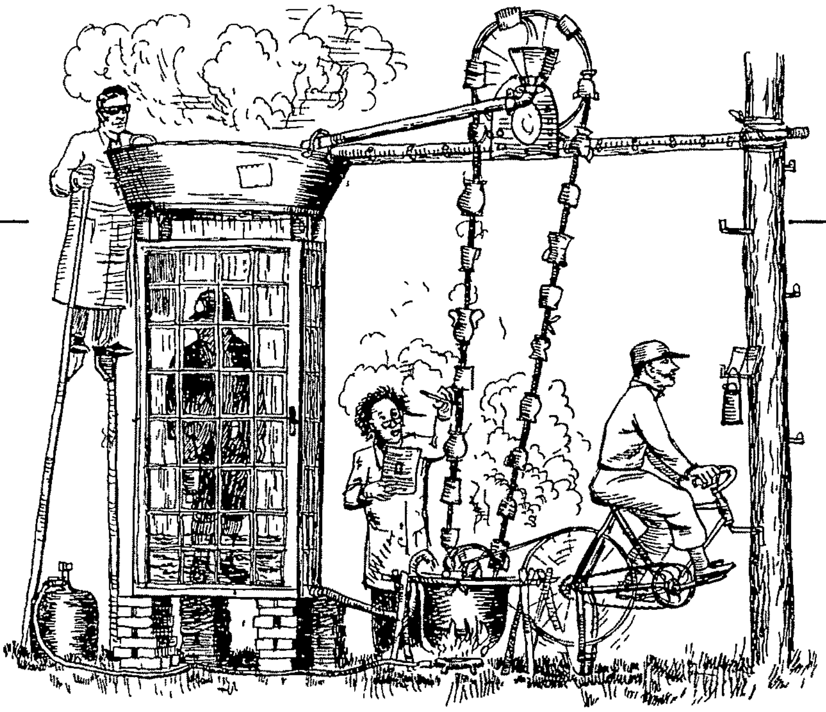
The glass electrode pH Amplifier operated from the mains, and presenting a direct indication, provides the simplest, quickest and most efficient method of measuring and controlling pH The use of this type of instrument is quickly becoming a major feature of the current trend towards instrumentation in industry

SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO LTD., GRANTA WORKS, CAMBRIDGE

W G53

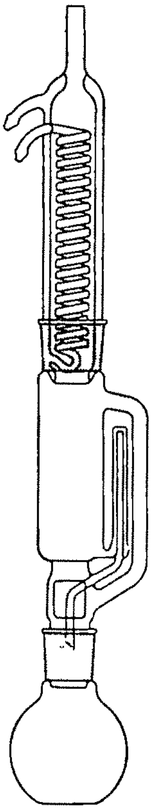
Our Cartoonist's Impression of Soxhlet extraction.



The quicker way
is the
"QUICKFIT" way!

An improved design of the liquid/solid (Soxhlet) extractor incorporates the new non-dribble syphon which is protected by the vapour tube. This adds greatly to the strength of an already robust apparatus. Suitably sized Whatman thimbles, which are used in conjunction with the extractors, are kept in stock and are listed in our catalogue, which is yours on request.

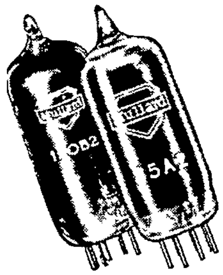
QUICKFIT & QUARTZ Ltd
INTERCHANGEABLE LABORATORY
GLASSWARE
Dept. Z.X., "Quickfit" Works,
Heart of STONE, Staffs.
Telephone: Stone 481



"QUICKFIT"
SOXHLET
EXTRACTION

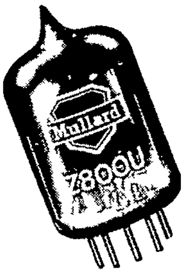
Britis
Instrumen
Industrie
Exhibitio
Earl's Cour
28th *June*—19th *Jul*
Stand No. 1
Block C

QUICKFIT



STABILISERS & REFERENCE TUBES

Characterized by close tolerance burning voltages, very small voltage fluctuations, freedom from sudden large jumps throughout working current range, and long-term stability.

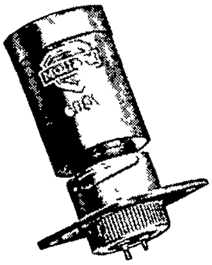


TRIGGER TUBES

Cold cathode tubes for particle counters and very low current stabilisers

ELECTROMETERS

Triode and pentode octal and subminiature types for use with radiation monitors, photocells and other devices where a high input impedance is essential

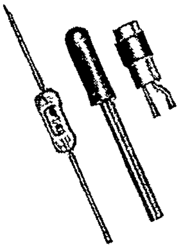


PHOTOCELLS

Vacuum and gas-filled photoelectric, and lead sulphide photoconductive types for light-activated relays and infra-red applications

SPECIAL QUALITY VALVES

Special counterparts of popular types, designed and manufactured to withstand shock and vibration and to provide extra all-round reliability



SEMI-CONDUCTOR DIODES & TRANSISTORS

A range of germanium diodes and transistors for scaling circuits, very low power H T generation and for trigger circuits

Valves and Tubes for Nuclear Physics

Among the valves and tubes in Mullard's comprehensive range are many that are suited for the most specialised and complex applications Whatever your interest in electronic valves and tubes, your enquiries will be welcomed at the address below where full technical details and characteristic curves are available

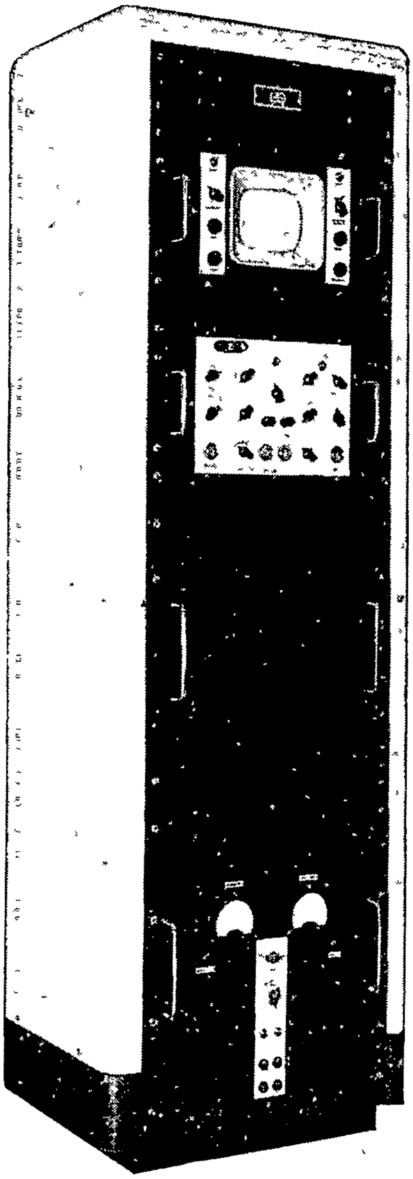
Mullard

MULLARD LTD , COMMUNICATIONS & INDUSTRIAL VALVE DEPT
CENTURY HOUSE, SHAFTESBURY AVENUE LONDON, W C 2

MVT155

PROGRESS IN CONTROL

SUNVIC
PULSE HEIGHT
ANALYSER



An instrument for the analysis of a complex pulse amplitude spectrum into groups of known height according to their voltage amplitude

It displays up to a maximum of 120 channels and can store 1,200 binary digits. The design is based on that of Hutchinson & Scarrott (*Phil Mag*, 42, 792, 1951) and the instrument is made under licence from the N.R.D.C.

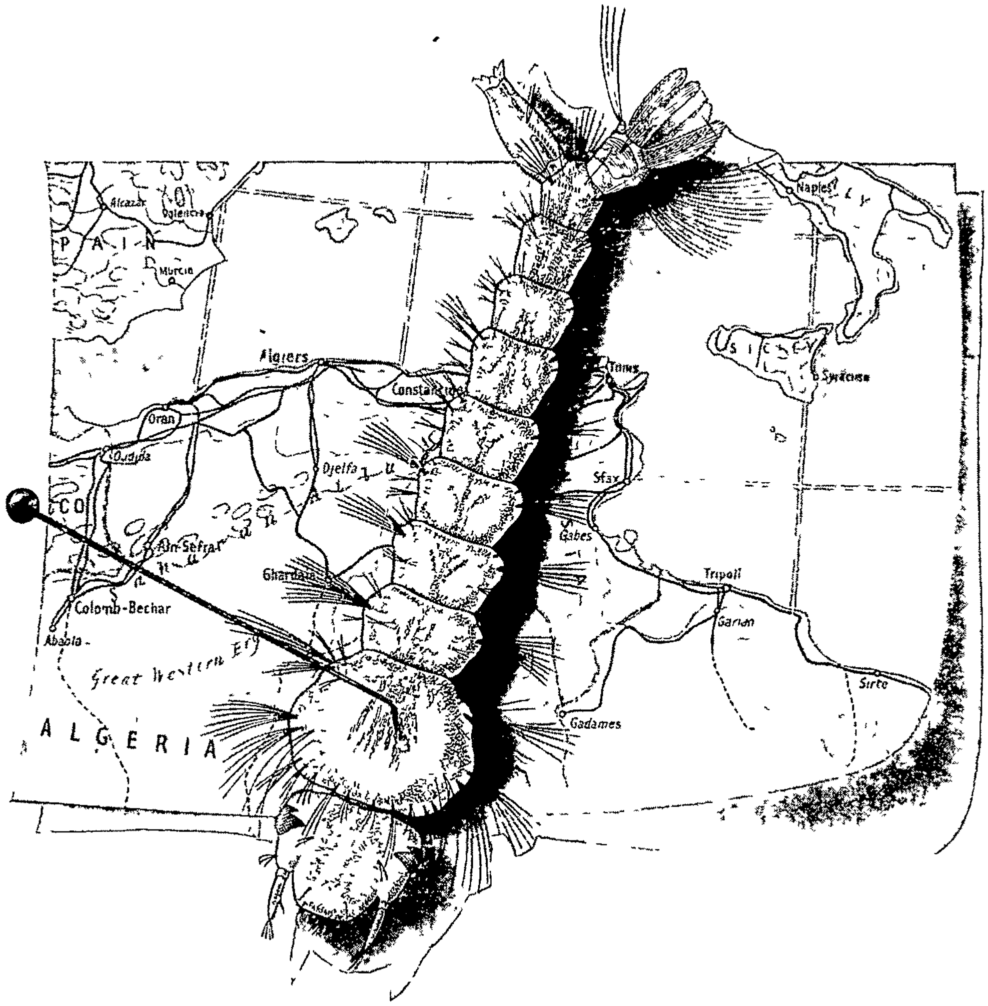
EQUIPMENT BY SUNVIC

SUNVIC CONTROLS LTD (*Special Products Division*), *No. 1 Factory, Eastern Industrial Estate, Harlow, Essex* Telephone Harlow 24231/5

Manufacturers of Pneumatic and Electrical Instruments for detection, measurement, control and recording of Temperature, Flow, Liquid Level, Specific Gravity and Pressure, in Science and Industry Vacuum Pumping and Measuring Equipment, etc

Member of the A E.I. Group of Companies

TAS/Sc 305



The case of the *Culicine larvae* . . .

In Algeria the still, shallow waters of the rice fields are perfect breeding grounds for mosquitoes, anophelene mosquitoes that transmit malaria and culicine mosquitoes that plague man and beast Control measures are now being intensified throughout the infested areas, aimed at controlling all mosquitoes in the larval stage The Shell insecticide dieldrin — in granule form — has been chosen for this important work

Dieldrin granules have been chosen with good reason Dieldrin is deadly to *all* species of mosquitoes, even the difficult-to-control culicines In the rice fields, conventional dusts and sprays are caught by vegetation above the surface and largely wasted, but the specially prepared dieldrin granules, applied from the air, penetrate the foliage and get right down to the larvae in the water

15 to 20 lbs of granules to the acre — only a few ounces of actual dieldrin — are bringing even the heaviest infestations under complete control

Dieldrin's range of control is unique all mosquitoes and all other major disease-carrying insects More powerful, exceptionally persistent, giving surer kill at lower dosages, dieldrin is the outstanding insecticide developed in recent years for the protection of health against insect attack

Another recent Shell development is aldrin, fast becoming recognised as the most widely effective and most economical of all insecticides for use in the soil

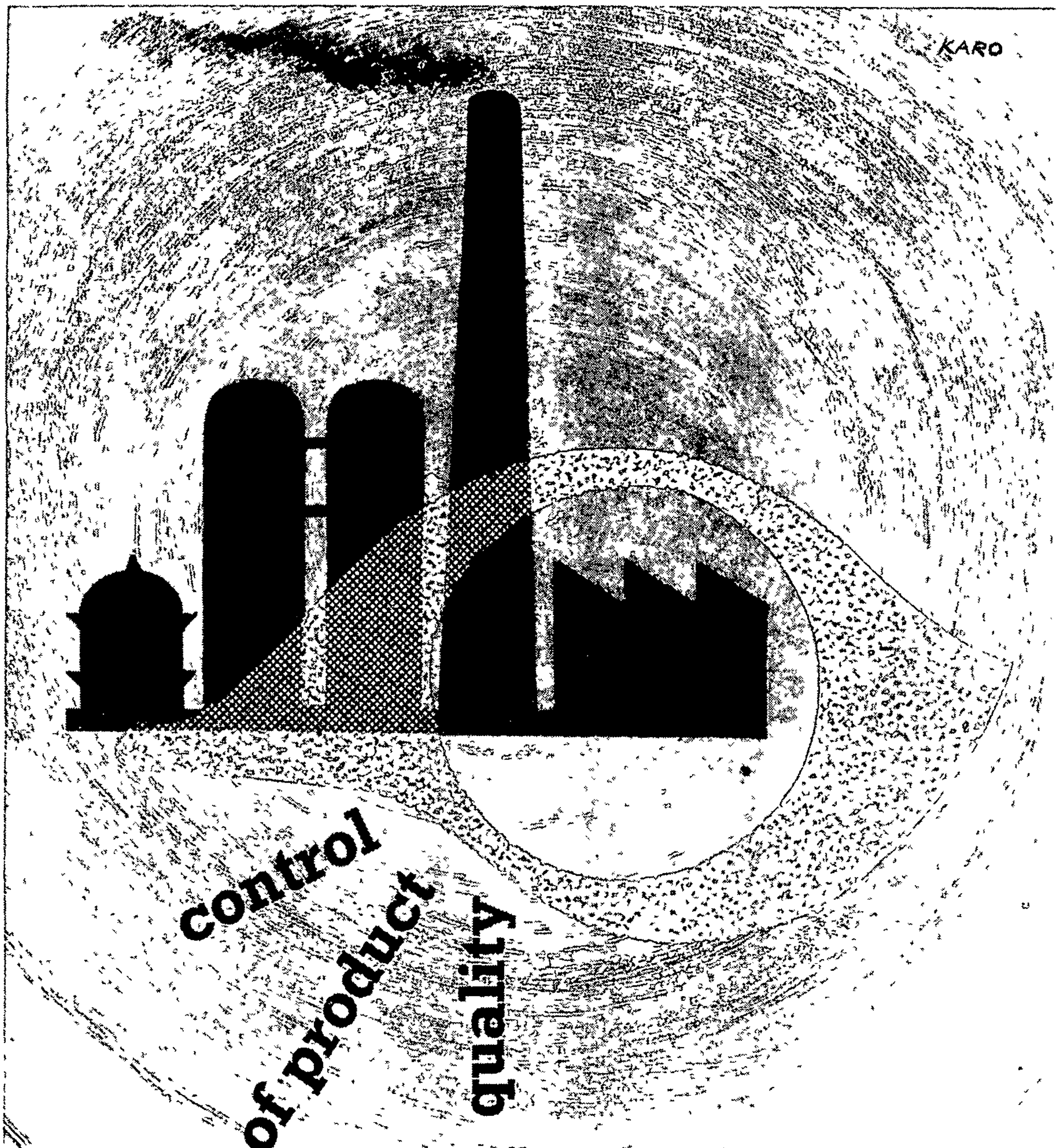
Have you an urgent pest problem in your area ?

dieldrin

dieldrin and aldrin are SHELL insecticides for world-wide use

For further information apply to your Shell Company

Issued by The Shell Petroleum Company Limited, London, E C 3, England



New products and new processes are the outcome of continuous research. It follows that the tools of research are applicable to process control. The Spectrophotometer, widely used in research laboratories for ultraviolet, visible and infrared investigations, is the ideal instrument for routine analysis and control of product quality

Chemists who need to keep an eye on things are invited to write for details to Unicam Instruments of Cambridge.

UNICAM
SPECTROPHOTOMETERS

NATURE

No. 4452 SATURDAY, FEBRUARY 26, 1955 Vol. 175

CONTENTS

Page
National Parks in Great Britain 355

Physical Chemistry of High Polymers By Prof G Gee, F R S. 358
Maxwell's Theory and some of its Applications By R Neumann 358
Australian Ornithology By Dr A J Marshall 359
Development of Indian Pharmacy By Dr E Ashworth Underwood 360
Projective and Metric Geometry By Prof H T H Piaggio 360

First Observations on a Living Cœlacanth By Prof J Millot 362
Nutritive Value of Bread By Miss M W Grant 363
A Mandibular Fragment, probably of the Saldanha Skull By Prof M R Drennan and Dr R Singer 364
Dislocations, Work-hardening and Creep By Prof N F Mott, F R S 365

Obituaries

Prof P J Heawood, O B E By Sir James Duff 368
Dr C H Hampshire, C.M G By T C Denston 368
Lord Charnwood. By G. H Giles 368

News and Views 369

The Nuffield Foundation Annual Report 374
The Mining Industry in Britain By Prof R J Sarjant, O B E 376
Overseas Food Corporation Annual Report 376
Meteoric Particles in the Atmosphere 377
The Earth's Exterior Atmosphere and the Counterglow By T. Gold 377
Mobility of Manganese, Magnesium and Potassium in Leaf Tissues. By H C. Ruck and Prof F G Gregory, F.R S. 378
Structure of Tobacco Mosaic Virus By Dr Rosalind E Franklin 379

Letters to the Editors

The 'Horizon' of the Steady-State Universe —T Gold , The Writer of the Article 382
Influence of Liquid Films on Fibre Friction —G King 383
Non-linear Microphonic Response of Labyrinth Organs to Stimuli consisting of Two Pure Tones —Hl de Vries, J W Kuiper and D R Ubbens 383
Interpretation of Differential Thermal Curves of Mixed-layer Minerals of Illite and Montmorillonite —W F Cole 384
Anhydrous Hydrogen Fluoride as a Collagen Solvent —Russell E Dreikorn and Vincent O'Gorman 385
Reactions of Hyponitrites and Nitrites —Dr Trambaklal Mohanlal Oza 385
A Simple Method for the Determination of Glycogen in Liver —Dr L. Gyermek and Dr G Fekete 386
In vitro Synthesis of Ribonucleic Acid in Reticulocytes —J Kruh and H Borsook 386
Relation of the Ground Substance of the Central Nervous System to the Blood – Brain Barrier.—Arthur Hess 387
Effect of Methylcholanthrene on Ovaries of Mice —Mrs B K Batra 388
Morphine Antagonists —Prof F H Shaw and A Shulman 388
Size of the Myosin Molecule —K Laki and W R Carroll 389
Visual Pigments and Vitamins A of the Clawed Toad, *Xenopus laevis* —Prof. George Wald 390
A New Structure observed in *Trypanosoma evansi* (Indian Strain) —Prof H N Ray, N. N Das Gupta, M. L. De and A Guha 392
Life-cycle of *Porphyra capensis* Kutz —Judith M Graves 393
Positional Pseudo-Alleles in Diploid Potatoes —Dr Kenneth S Dodds 394
Hereditary (Seed-borne) Symbiosis in *Ardisia humilis* Vahl —Prof S R Bose 395
Blood Supply of Mystacial Vibrissæ —M G Scott 395
Adult Behaviour-Pattern of *Anopheles gambiae* in Mauritius.—James G Halcrow 396

Recent Scientific and Technical Books Supp. viii

CHAPMAN & HALL

Just Published

NUCLEAR GEOLOGY

A Symposium on Nuclear Phenomena in the Earth Sciences

Edited by

Henry Faul

With Twenty-six Contributors

Size 9½ *in* × 6 *in* 414 *pages* *Illustrated* 56*s net*

ELEMENTS OF ECOLOGY

by

George L. Clarke

(Harvard University)

Size 9½ *in* × 6¾ *in* 534 *pages* *Illustrated* 60*s net*

SUPERFLUIDS

(Vol. II.—Macroscopic Theory of Superfluid Helium)

by the late

Fritz London

(Duke University, U S A)

Size 9½ *in* × 6 *in* 835 *pages* *Illustrated* 96*s net*

37 ESSEX STREET, LONDON W.C 2

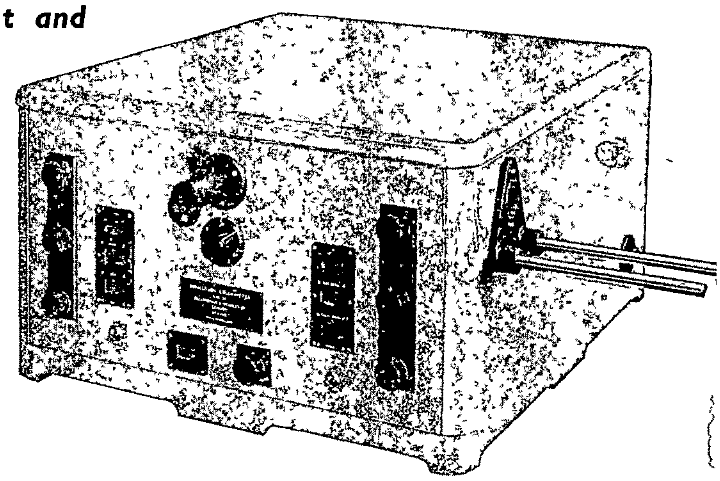
PRECISION INSTRUMENTS

Donaldson 6-stimuli Colorimeter

for the accurate measurement and standardisation of colour

The most accurate and reliable colour measuring instrument available for paints, woollens, textiles, signal glasses, powders, liquids, printing inks, foodstuffs, and for general research where colour measurement is important.

We shall at all times be pleased to demonstrate the above instrument at our showroom, or to give any help or advice in connection with the application of this instrument to your problems.



Bellingham & Stanley Ltd.

DEPT. N, 71 HORNSEY RISE, LONDON, N 19

PHONE ARCHWAY 2270

NATIONAL PARKS IN GREAT BRITAIN

THE fifth report of the National Parks Commission* appears at a moment when at least wo matters of current controversy give particular point to the retrospect and prospect with which the Commission concludes the normal review of a year's activities Taken by themselves, the year's activities of the Commission constitute a record of creditable achievement. No new 'parks' were designated in Great Britain during the year, though progress is apparent with the designation of the Yorkshire Dales National Park, and the negotiations for a Cheviot National Park are particularly encouraging, both because a proposal was put forward on the initiative of the Northumberland County Council for a Northumberland National Park embracing also the Kielder moors and part of the Roman Wall area, and or the evidence it affords of a clearer and wider understanding of the purpose of a 'national park' Preliminary discussions have also been held regarding he Brecon Beacons and the Black Mountains area, on the other hand, except in the Peak District National Park, the administrative arrangements still eave much to be desired and there is little evidence here of progress towards fulfilling the purpose of the Act. The Pembrokeshire Coast National Park Committee has taken the welcome step of setting up an architectural panel to advise on certain planning applications before submission to the Committee, and he Commission professes satisfaction with the work carried out by the Peak District and Lake District National Park Planning Boards. For example, the ormer Board has completed its survey of 'open country' and has made substantial progress in negotiations with landowners for the conclusion of public access agreements in the Kinder Scout area The Lake District Board has organized the permanent camping site at Silecroft and made substantial progress with the development of organized caravan ites by private enterprise.

Much of the work of whatever administrative authority is established for a national park will onsist of the quiet implementation of specific proposals and of educating public opinion—securing o-operation and higher standards of conduct in egard to litter and other forms of vandalism in the Park areas The form of administration is important, however, when a clash arises between some immediate interest of the local community or the specific requirements of a government department or national orporation and the national interest in the preservation of amenity which the National Parks Commission was established to safeguard Moreover, while the local authorities are even less able than the National Parks Commission to resist the pressure of the powerful nationalized corporations and government departments, the omission to provide the National Parks Commission with adequate financial resources and staff of its own increases the risk of conflict between the local authorities and the Commission.

The fact that such unsatisfactory systems as that adopted for the Snowdonian National Park have worked rather better than could have been expected does not affect the main point · apart from the absence of an adequate overall view, and greater danger from the operations of the Electricity Authority or Service Departments, for example, the local authorities are, at best, subjected to an unreasonable strain between local and national responsibilities, at worst, relations between them and the National Parks Commission can be exacerbated and deadlock ensue.

Ample evidence of this is provided by the present report There is no mention in it of the project for a Cornish National Park, negotiations for the boundaries of which began nearly three years ago. In its previous report the Commission referred to the recommendation of the Cornwall County Council that the project should be deferred *sine die*. The Commission then recorded its refusal to acquiesce in a proposal to suspend the intentions of Parliament in this way, but there is no hint in the present report as to when the Commission proposes to renew the discussions, and neither in its retrospect nor in its prospect does the Commission judge the flouting of Parliament by local authority important enough for comment.

Exmoor provides another example of failure to reconcile the divergent views of county councils and the Commission, but here the Commission has proved less acquiescent and proceeded with the designation The designation order, after a public inquiry in June 1954, was confirmed by the Minister without modification on October 15, 1954. It should be noted, moreover, that, while the designation order was opposed by the Devon and Somerset County Councils and the Williton and Dulverton Rural District Councils, it was supported by the Lynton and Minehead Urban District Councils Again, the Commission is disappointed at the slow progress in creating footpath agreements in regard to the long-distance routes, no fresh proposals have been submitted for such routes With regard to the path along the south coast of Cornwall, which, when complete, will give, with that already approved on the north coast, some 270 miles of continuous path around the whole coast-line of Cornwall, the Ministry has taken the initiative in approaching the local authorities concerned in giving assistance and urging them to complete the work as soon as practicable.

It is obvious that finance is a major factor, both in the slow progress with the long-distance routes and in the attitude of some local authorities to the designation and administration of national parks. If the National Parks Commission were provided with adequate resources and the local authorities were no longer liable to be called upon to finance national projects out of local rates, the extent to which co-operation already exists, and the support which the preservation of amenity already enjoys, indicate that with the disappearance of the clash of interests and loyalties much more rapid progress would be possible Apart, however, from noting that the Minister of Housing and Local Government has now made regulations authorizing the payment of exchequer grants to local authorities towards the cost of carrying out certain specified duties in national parks, the report scarcely refers to the financial aspect. The campaign for the use of the National Land Fund, as was originally intended, to finance national park operations is never mentioned.

---

* National Parks and Access to the Countryside Act, 1949 Fifth Report of the National Parks Commission for the year ending 30th September 1954 Pp iv+56+8 plates (London H M Stationery Office, 1954) 3s 6d net

The concern of the Commission over the slow progress in creating footpath agreements, however, does not arise from financial considerations This is well brought out by the Pennine Way, for which only twenty-four and a half more miles of rights of-way have been acquired, leaving some thirty-eight and a half miles to be acquired The difficulties which arose during the year in regard to three sections of this route were all in relation to alleged risks of pollution of water supply. One in the area of Holmfirth Urban District Council resulted in the Minister's upholding the Commission that, in view of the Huddersfield Corporation's resources of long storage, filtration and sterilization, the risks of harming the purity of supply were too remote to justify abandoning a route devised for the safety of walkers. The Commission still hopes to find a path in the area of the Colne Valley Urban District Council which will be acceptable to all parties, but the third dispute, in relation to a proposed path in the area of Crowden in Longdendale, raises difficulties which are exacerbated by the Minister's decision, announced on December 30, 1954, to uphold the objection of the Manchester Corporation.

Mr. Duncan Sandys's decision was based on his acceptance of the evidence that in certain circumstances the waters from Crowden Great Brook pass quickly into the public water supply, the safety of which then depends solely on the sterilization and on the original purity of the water Quite correctly, the Minister refers to the stress laid by the Gathering Grounds Sub-Committee of the Central Advisory Water Committee in its report seven years ago on public access to gathering grounds, on the wisdom of having several lines of defence for the protection of public water supplies, but one of the reasons given in that report for permitting public access was that the most stringent control of public access could not eliminate risk of contamination, and that other means of protection were desirable Restrictions on public access were rejected because, while fallible, their imposition was liable to cause ill-will and reduce respect for more important restrictions

While disregarding the advice of independent expert opinion in this way, the Manchester Corporation has adduced no convincing fresh evidence that the risk of contamination is serious, and it ignores the risks attached to footpaths which are much more frequently used both in the Greenfield and Longdendale valley in the Thirlmere and Haweswater catchment areas The acceptance by the Minister of the Manchester Corporation's proposal carries disturbing implications This reversal of a policy pursued without demonstrable risk for more than half a century and supported by independent expert opinion will not engender the goodwill and public co-operation on which the Heneage Committee rightly laid stress. Moreover, the absence of any attempt to deal urgently and effectively with the risk which the Corporation alleges to exist, by means which expert opinion regards as effective, exposes the Corporation to adverse comment

The observations of the National Parks Commission on the decision have yet to be made public, but th situation will doubtless be discussed in its next annua report. Meanwhile, the scientist will note a furthe example of the disregard, by a local authority, o expert opinion and national interests when the clash with local convenience or interests Th Minister's decision, moreover, will arouse doubts a to the soundness of his concern for the purity o public water supplies and the genuineness of hi interest in access to the countryside.

There is some slight resemblance between th dispute and that over the erection of a televisio station at Hessary Tor in the Dartmoor Nationa Park, where the Minister's decision to grant per mission, subject to agreement, *inter alia*, on detai of siting with the local planning authority, also run counter to technical advice submitted on behalf o the National Parks Commission by Sir Rober Watson-Watt The Commission is clearly unhapp at this over-ruling of the claims of amenity in national park area. It observes in another connexio when the local authority reversed an agreed decision "if all planning authorities acted in this way, amenit considerations would be likely to receive little mo than lip service, since all an Electricity Board woul need to argue, in order to bring the authority t consent to a particular scheme, is that they will n proceed unless they are allowed to do so in the wa they proposed"

Parliament, however, has made the National Par Commission responsible for bringing to the attenti of Ministers any development the effect of whi appears likely to prejudice the beauty of any are especially where that area is in a national par Planning authorities carry a similar responsibili for their own areas, and the Commission right holds that that duty is not properly discharged unle the claims of amenity are placed before Ministe with the right degree of emphasis That wou indeed ensure that the responsible Minister is possession of all the pertinent evidence, where vari public interests are in conflict, before arriving at decision. It does nothing, however, to remove t objection that the responsible Minister may be jud in his own cause.

In addition to more than one thousand proposals or electrification referred to the National Parks ommission for comment during the year by various rea boards, the Commission was consulted by the ritish Electricity Authority on national electricity chemes relating to power-stations or the super-grid he Commission recognizes that the area boards are ot unresponsive to the claims of amenity, and sually the Commission has been able to assent to e proposals or to agree on modifications which have ssened the damage to the amenities, though it ust be admitted also that sometimes the authority the boards have been negligent in their public lations duties Nevertheless, the Commission is metimes obliged to dissent, and it is now apparent at, particularly in relation to proposals for over-ead lines, the Commission is, in present circumances, liable to be placed in an impossible position here the electricity authority refuses to proceed ecause of the additional expense of putting cables derground, the National Parks Commission is ced with either abandoning its responsibility for e protection of amenity, or the areas concerned ay be deprived indefinitely of electricity supply

What is involved is well shown in the dispute over e supply of electricity to Borrowdale, Patterdale d Langdale in the Lake District National Park he Commission refers to the Borrowdale and Langle schemes in the present report, and the proposed pply schemes are being discussed with the Lake istrict Planning Board The North Western lectricity Board has, however, since submitted to e planning board a scheme for extending the pply line in Patterdale which will involve more an four and a half miles of new line, all carried ove ground on poles or pylons Mindful of its atutory duty, the planning board has suggested stead that the line shall run underground for three its four and a half miles What is said in the ational Parks Commission's report indicates that e electricity board is likely to answer that if the e is put underground the whole of the additional st must be borne by the individual customers pplied and that it cannot be spread over a larger ea. Few of the prospective customers, some of om have been waiting for thirty years for the pply, can afford to pay several hundred pounds tra, and unless the planning board gives way, e scheme will be dropped again The position is gravated in the Lake District, because, unlike me regional electricity authorities, the North estern Electricity Board has consistently declined spread the cost of a short stretch of underground e over the whole of a large project In consequence, the planning authority refuses to sanction overad lines, the electricity board refuses to proceed ere is no public inquiry at which the matter can thrashed out, and the planning authority incurs loquy for doing its statutory duty.

This dilemma, however, is arising repeatedly, and t only in the Lake district, like the clash over e administration of the national parks, it arises entially because the National Parks Commission and the national park boards have no real financial resources of their own It is reasonable enough to argue that when the national interest in natural beauty conflicts with some local need like that for cheap electricity, the extra cost of reconciling beauty with the local need should be met by some contribution from national funds The National Parks Commission and its various Park Planning Boards would be the logical instruments for any such payments, but they have neither the statutory powers to make payments, nor the resources from which to do so, at any rate until the National Parks Commission receives the assistance from the National Land Fund or some such source which Mr Hugh Dalton specifically promised when the National Parks and Access to the Countryside Act was passed

The National Trust and the Youth Hostels Association are already benefiting from the National Land Fund, and it has been strongly urged that the National Parks Commission should be supported from the same source Adequate finance would go far to remove some of the existing opposition to the work of the Commission and would facilitate a more vigorous educational campaign to remove misunderstandings which hinder it and prevent the full public co-operation upon which the success of its work ultimately depends Perhaps the most discouraging feature of the present report is that the Commission seems to accept tacitly the parsimony which thus hinders its work—which has delayed into its fifth year, for example, the appointment of a second assistant field officer, bringing its technical staff to three

There is in this report ample evidence of successful efforts to prevent or minimize disfigurements of natural beauty, of co-operation from local authorities and other public bodies and quiet persistence in the task of public education. The Commission itself recognizes that its efforts to make the national parks better known and understood require increasing help from other bodies and individuals concerned with the beauty and preservation of the countryside, and that much has still to be done, especially among young people, to create a wide public awareness of the nature and purpose of the national parks in Great Britain But one looks in vain in this report for any evidence that the preservation of amenity is regarded as a real national interest by the Minister himself, still more by the Government as a whole While, however, the Government regards national parks or nature reserves and the preservation of natural beauty as something to which no more than lip service need be given, the danger persists that departmental interests will irretrievably destroy them. No ministerial discouragements can really absolve the National Parks Commission for its failure, in reviewing the first five years of its work, to insist on the over-riding need for a short amending measure to the Act, which, taking into account that experience, would endow the Commission with the financial resources it needs, and help to restore its pioneering spirit.

PHYSICAL CHEMISTRY OF HIGH POLYMERS

Principles of Polymer Chemistry

By Prof. Paul J. Flory. (The George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University.) Pp. xvi+672. (Ithaca Cornell University Press, London Oxford University Press, 1953) 68*s*. net

IN 1935, the Faraday Society held a General Discussion on the subject of polymerization and condensation. At that time it was still possible to debate seriously whether natural and synthetic polymers could properly be regarded as strictly comparable materials, the properties of which were to be understood in terms of ordinary physicochemical principles, applied to long-chain molecules. This Discussion may be considered to mark the beginning of the surprising growth of polymer science which has taken place in the past twenty years. This same period coincides with the research activity of Prof. P. J Flory, who now, in the book under review, presents a systematic account of these developments. Flory's own contributions to polymer science have been both profound and extensive. In 1937 he set out clearly the now generally accepted principles of vinyl polymerization processes In 1942, he evaluated the entropy of mixing of high polymers with liquids He has made notable contributions to our understanding of the equilibrium and flow properties of polymer solutions, of polymer crystallization, and of rubber elasticity. A book by Flory will therefore command wide attention, and it is safe to say that its readers will not be disappointed

The plan and scope of the book reflect the author's interests, and, as its title indicates, it is concerned with physico-chemical principles rather than with the presentation of detailed factual information As a text-book for a postgraduate course on polymer science it could scarcely be bettered, while as a reference book it provides a theoretical background to current research activity and applications of high polymers

Following two introductory chapters, the author deals first, in Chapters 3–5, with the mechanisms and kinetics of polymerization reactions, discussing in turn polycondensation, free-radical polymerization, copolymerization, and (briefly) ionic polymerization. These chapters, in conformity with the plan of the book, discuss the principles involved, and quote ample illustrative data, but do not compete with or replace the more specialized texts on polymer reactions

The next main section of the book (Chapters 6–9) is broadly concerned with the structure of polymers, both linear and cross-linked, with especial reference to the determination and distribution of molecular weights. The various experimental techniques are adequately outlined, but the main thread of argument is provided by thorough discussion of the principles of the methods, the origins of molecular-weight distribution, and the correlation of theory with experiment. The application of these methods to specific polymers and the compilation of detailed results have very reasonably been held to lie outside the scope of the book

In Chapter 10, the author turns to the problem of chain configuration, outlines the random flight approximation and discusses briefly some of the restrictions imposed by bond angles and rotation barriers. Discussion of rubber elasticity follows naturally in Chapter 11, and here, as elsewhere in the book, the author has chosen to develop the subject simply and systematically without interrupting his argument to discuss disagreements in points of detail which have been expressed by different workers in the field

Chapter 12 contains a statistical derivation of the thermodynamic properties of polymer solutions The limitations of the elementary lattice treatment are dealt with and the excluded-volume problem discussed by Flory's own method based on the analogy betweer polymer solutions and imperfect gases. The usefulness and power of these methods are illustrated by reference to a few well-chosen examples.

Chapter 13 is entitled "Phase Equilibria", and i concerned in the main with the applications o the results of Chapter 12 to problems of polyme solubility, fractionation and swelling. Polyme crystallization is discussed in a surprisingly shor section of a dozen pages.

The final chapter contains a concise but ver satisfying account of the important though difficul problem of the viscosities of polymer solutions. Here as throughout the book, the treatment is essentiall original, the contributions of various workers bein interwoven and often illuminated by the author' systematic presentation No attempt has been mad to review the vast literature which has grown aroun the empirical use of viscosity as a measure c molecular weight

This book can be unreservedly recommended t beginners and experts alike Although it would b easy, as the author himself points out, to mentio subjects which have been omitted, the field covere is very broad Readers unfamiliar with the method of statistical thermodynamics will find some section difficult without supplementary study, but physic principles are never submerged in mathematic Clarity of expression and depth of physical insigh are outstanding characteristics of the book, as the have been of Flory's research papers All workers i polymer science owe him a debt of gratitude for th monograph

G. GEE

MAXWELL'S THEORY AND SOM OF ITS APPLICATIONS

Electromagnetics

By Prof. John D. Kraus. (McGraw-Hill Electric and Electronic Engineering Series) Pp. xiii+60 (London McGraw-Hill Publishing Co , Ltd., 1953 76*s* 6*d*.

MANY years ago, the reviewer overheard a co versation between two colleagues about recently published book, when one of them remarke "If one masters Maxwell's theory the book can read like a novel". At that time there were n many people who could boast of mastering th theory Some years earlier, as Michael Pupin tells his autobiography, he came to England and tried get information about Maxwell's theory but co not find any university here to help him and had go to the Continent and to study with Helmholt But times have changed since then, and there ex at present, besides Maxwell's original work, wh perhaps is not easily understood, quite a few co prehensive treatises on electromagnetic theory.

In spite of this fact, the book under notice should have many readers who want to acquire a sound foundation for a thorough knowledge of the subject It is written in a fluent style by a scientist possessing outstanding pedagogic skill It is intended for students acquainted with general physics, the elements of calculus and to some extent with vector analysis, although vector concepts are lucidly developed in the book so far as they are needed But the book is also very suitable as a work of reference for research workers The author stresses throughout the importance of using dimensional relations of the quantities concerned for checking the correctness of equations between them The rationalized Giorgi system of units is applied based on the metre, kilogram and second, with the coulomb used as fourth fundamental unit

The book contains nearly four hundred well-chosen and very clear illustrations, many worked examples within the text and numerous problems at the end of each chapter Field mapping methods are shown n their application to electric and magnetic fields as well as to current, heat and fluid flow

The first two chapters deal with the static electric field, starting with Coulomb's law and deriving Gauss's law on the relation between electric flux density and charge In the second chapter the capacitor, coaxial, two- and single-wire transmission lines, Maxwell's divergence equation and the equations of Poisson and Laplace are discussed. In the third chapter, dealing with the steady direct current, the laws of Ohm, Kirchhoff and Joule are discussed and the relevant current parameters are defined. Finally, Laplace's equation for conductive media is given. The fourth and fifth chapters deal with static magnetic fields in air and in ferromagnetic materials, espectively The magnetic field is here introduced not as that of a permanent magnet but as that produced by a steady current, while permanent magnets and Coulomb's law for magnets are dealt with much later Flux and flux density, magnetic moment, solenoids, inductors and inductance, permeability, magnetizing force and magnetomotive force are defined Then Biot-Savart's and Ampère's laws are stated in the usual form and, after a brief xplanation of the vectorial product and its proprties, also in vector notation Ampère's law is given onnecting the magnetizing force of a loop with the urrent enclosed and, after explaining the notion of url, it is stated in the form given by Maxwell though n the more modern vector notation. In the sixth hapter the effect of electric and magnetic fields on harged particles is discussed and the cathode ray ube, the cyclotron and the mass spectrograph are reated as examples While these first six chapters were concerned with static and steady states, fields hanging with time are introduced in the seventh hapter Faraday's law and its mathematical expresion due to Maxwell are given, and the betatron and he fluxmeter for the measurement of magnetic fields re briefly described Here, as elsewhere, Maxwell's otion of the displacement current is given due onsideration

Chapter 8 gives a summary and tables of all the Maxwell equations in their integral and differential orms, first for the general case, then for free space, or harmonic variation and for steady and static tates

The rest of the book is dedicated to selected pplications of Maxwell's theory. In Chapters 9 and 0 the plane waves in dielectric and conducting media are discussed, wave equations are derived and some of their solutions are given The difference between phase velocity and group velocity is lucidly illustrated by the movement of a caterpillar The Poynting vector and its uses are introduced Chapters 11–13 deal in greater detail with transmission lines, with wave guides and antennæ respectively, and the last chapter is devoted to boundary-value problems At the end of this chapter a brief introduction is given to the method of conformal transformations

As in dealing with the solution of wave equations in cylindrical and spherical co-ordinates use is made of Bessel, Neumann, Hankel and Legendre functions, these are briefly discussed and partly illustrated in the appendix Besides this, the appendix contains a detailed table of the units used and their dimensions, a section on field-mapping technique, a table of dielectric materials and various mathematical relations A bibliography and a combined name and subject index conclude the book

This survey of the contents of the book shows how much information can be found in it Two slight omissions may be noticed In dealing with the Poynting vector, a conversion formula is used connecting the divergence of a vector product with the curls of its factors The formula is also to be found in the appendix, but no proof is given for it Of course, it may be verified easily by applying the definitions of divergence and curl and the rules given in Chapter 4 for the cross-products of unit vectors Also the vector identity used in the section on the general development of the wave equation is not proved Perhaps in a second edition the proofs might be given in the text or used as set problems in Chapter 4 But these are very minor criticisms of a well-produced book which may be strongly recommended

R. NEUMANN

AUSTRALIAN ORNITHOLOGY

The Literature of Australian Birds

By Major H M. Whittell. Pp 788+32 plates (Perth, W Australia Paterson, Brokensha, Pty, Ltd, 1954) £A 3 10*s*

ALTHOUGH Australia has been settled by Europeans since 1788, little serious attention has been paid to the study of its birds For this there are two primary reasons First, there has been in Australia no hard core of scientifically trained zoologists interested in the group such people, in a young country, have generally almost inevitably gravitated into economic zoology Secondly, bird-watching has never become popular In some respects this is very good, in that it makes it possible, in an Australian capital city, for an experimental scientist to trap sparrows, starlings or other pests without being assailed by protesting fanatics In another respect, it is unfortunate in that there has never developed there any large corpus of serious and gifted amateur ornithologists of the sort who have done such valuable work in Great Britain in the past fifty years

So it is that the late Major H M. Whittell has been able to include the whole literature of Australian birds from 1618 to 1950 in one moderately bulky volume This fine bibliography is the result of many years painstaking work in metropolitan newspapers as well as technical journals The perusal of the former is a sad necessity because the press of early Colonial days sometimes published the initial descriptions and names of new (or supposedly new) species given by pioneer museum men who rushed accounts into local newspapers in order to get priority.

Major Whittell's book is divided into two parts covering the periods 1618–1850 and 1850–1950. The first is of particular interest in that it deals with the accounts of the great naturalist-explorers in what can almost be called the pre-laboratory era. It relates little-known information brought back by the early Dutch navigators, including the log-record of Antonie Caen, of the *Banda*, who in 1636 found (as did De Vlaming, of the *Geelvinck*, sixty years later) that the supposedly fabulous black swan was a reality, and not even a rarity, after all. There is included, too, much of other early information brought to Europe by French naturalists, and by the English buccaneer Dampier, and, of course, that obtained by Cook on his various voyages. There are data recorded by gifted early convicts and free-settler artists and naturalists, and the labours of Robert Brown (of Brownian movement), Charles Darwin, T. H. Huxley and many others have not been forgotten.

The second and longer part is devoted to the condensed autobiography and complete bibliographies of individual naturalists.

"The Literature of Australian Birds" will be, no doubt, expanded as new documents come to light, but it is unlikely to be replaced and must, in fact, be indispensable to anybody interested in ornithology of the Australasian region. It is much to be regretted that its author, an English officer who first studied zoology in his youth under Cossar Ewart, and who decided to live in Australia after the First World War, did not live to see its publication. The only serious defect in the first edition is the lack of a species index. It is sold in paper covers in order to reduce expense. A. J. MARSHALL

DEVELOPMENT OF INDIAN PHARMACY

History of Indian Pharmacy

By G. P. Srivastava. Volume 1. Second edition. Pp. xvi+277. (Calcutta: Pindars, Limited, 1954.) 12 rupees, 8 annas; 2.50 dollars.

THREE different systems of medicine have been practised in India since early times. The most ancient system, the Ayurvedic, was the original system which owed nothing to external influences. It was practised until about the end of the twelfth century A.D. From that date until the end of the eighteenth century it was augmented or supplanted by the Arabian system, the Unani Tibi. At the end of the eighteenth century the modern Western system was introduced by the British. The first volume of this work—all that is published so far—deals only with the Ayurvedic system, and this second edition has followed very rapidly on the first.

The two great works of Indian medicine are the Charaka-Samhita and the Susruta-Samhita. The eight sections of Charaka's work deal fairly comprehensively with the preparation and use of drugs, and the treatise by Susruta extends this practice and also deals with surgery. There have unfortunately been wide discrepancies in the dates assigned to these two treatises. The author adopts the dates 1000–800 B.C. for Charaka and 1000–600 B.C. for Susruta. In his foreword, Dr. Urdang points out that the Chronology Committee of the National Institute of Sciences in India has recently accepted the dates A.D. 100 for Charaka and A.D. 200–500 for Susruta. Reference shows, however, that the report of the Committee which Dr. Urdang quotes is very brief, and it obviously indicates that the Committee based its findings largely on the fifty-year-old work of Winternitz. This matter is important in view of the possibility of the influence of Hindu medicine on the Greeks. The author contributes a few interesting points to this practically insoluble controversy.

In writing this book, Mr. G. P. Srivastava has leaned rather heavily on the standard works by Mukhopadhyaya, Dutt, Ray and others. But these works are now difficult to obtain, and the author has rendered a service by providing something more than a summary of the available material. Its value compensates for the slight quaintness of the English. It should be corrected by a European scholar before the next edition, and obvious misprints and errors—such as the 'three' humours of the Greeks, 'Gallen' for 'Galen'—should be removed. Despite these blemishes this book, which is written with enthusiasm and sincerity, will be found useful. There is an excellent index. E. ASHWORTH UNDERWOOD

PROJECTIVE AND METRIC GEOMETRY

Projective Geometry and Projective Metrics

By Herbert Busemann and Paul J. Kelly. (Pure and Applied Mathematics Series.) Pp. viii+332. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 6 dollars.

MUCH of this book differs widely from other treatises on geometry. The first three chapters are on lines which are now usual. Projective geometry is treated from the algebraic point of view. The authors consider that synthetic methods have lost their appeal for the present generation, especially in the United States, where there is a tendency to consider generality as the only criterion of value. After two chapters dealing with lines and conics in the projective plane, there is a third chapter dealing with the closely related affine geometry. The surprise for the reader comes in Chapter 4. This opens with a discussion of abstract metric spaces, in which for every two points there is some definition of distance though possibly quite different from the usual one. From the great variety of such spaces two special kinds are distinguished—Minkowskian and Hilbert's. Euclidean geometry reappears as a particular case of Minkowskian, and the non-Euclidean hyperbolic geometry of Lobachevsky is a particular case of Hilbert's. The fifth chapter considers non-Euclidean geometry, both hyperbolic and elliptic, in detail. In these two chapters there is a good deal about motion, area and perpendiculars.

The sixth and last chapter, entitled "Spatial Geometry", extends the results of the preceding five chapters from two to three dimensions, but it is written in a different style, intended as seminar work for the more mature student. Instead of the explicit exercises of the preceding chapters, the student is here asked to supply for himself the proofs of many of the theorems. The book concludes with a short bibliography and an eight-page index.

H. T. H. PIAGGIO

Seismic Prospecting for Oil

By C Hewitt Dix. (Harper's Geoscience Series) Pp. xx+414 (New York Harper and Brothers, London Hamish Hamilton, Ltd., 1953) 63*s*

AMONG geophysical prospecting methods, the seismic has now, and will probably retain, a favoured position ahead of all others. Gravity, magnetic and electric methods have their value, but successful interpretation is very uneven Recently, airborne magnetic surveys have given some useful general indications, but too much should not be claimed, Dr. Dix writes that their value "can hardly be overestimated", surely an over-statement of considerable splendour.

The success of the seismic method has been outstanding, but failures have also been many and costly Where conditions are simple and favourable, high-grade reflexions are obtained and no great skill is required to read the records, as with echo-sounding at sea where there is only one reflector and one simple medium At the other end of the scale, structure and strata may be so complex that the method must accept defeat, but the average experience is intermediate Many apparent seismic failures are, in fact, failures of interpretation, the more complex the conditions the more the skill required of the operator and the greater the personal factor in the final appraisal The chapters on interpretation, embodying the author's considerable experience, are the important practical contributions of this book, for the rest it has the marks of hasty assembly and, by the author's own admission, was dictated around his text figures The concluding section is a summary of the basic physics "written primarily for seismologists interested in the interpretation of seismic results"—implying that many are not so interested

[The late] G M Lees

General Chemistry

By Prof. W. F. Luder, Dr Arthur A Vernon and Prof. Saverio Zuffanti. Pp xiii+595. (Philadelphia and London W. B. Saunders Company, 1953.) 30*s*

IN this introductory chemistry for American university students, the authors cope with the vastness of the science by laying special emphasis on hose theoretical ideas which are of great significance for the understanding of chemical behaviour. Accordingly, after five chapters on elementary terms, processes and definitions, they build into a light framework of illustrative matter a thorough treatment of the periodic system, the electronic theory of valency and the new conceptions of the terms acid and base Other points of theory are included but not treated so fully Moreover, for their instructional value, attention is directed to the worth of Gardner's form of the periodic table—more customary forms are also given, to the system of exhibiting the properties and relationships of the elements by the author's atomic structure chart, and to such elpful generalizations as the classification of the elements based on the positions of the differentiating lectrons

The conception of an acid is treated in an equally thorough way and includes the discussion of the ater, the proton and the electronic definitions Then, in the next twenty chapters, appropriately itermingled with more theory, the elements in their eriodic groups are briefly studied After this we find four chapters on organic chemistry, one on analysis, and six on the metals The lanthanide and actinide series are included, and there is a good and unusual chapter on the systematic properties of related and similar metals Copious illustrations, sets of questions, numerous references to supplementary reading—many from the *Journal of Chemical Education*—and the use of the electronic theory throughout the book, combine to make this a stimulating text for first-year university students or for those studying for university scholarships G Fowles

Detailed Descriptions of Varieties of Wheat, Barley and Oats recommended by the National Institute of Agricultural Botany

Pp. 98 (Cambridge National Institute of Agricultural Botany, 1954) 20*s*

THIS publication, giving the full descriptions of the fifty cereal varieties on the Recommended Lists of the National Institute of Agricultural Botany for 1954, takes the form of a loose-leaf pocket handbook A single page is devoted to each variety so that reference is simple, and additions or deletions readily made, for it is hoped to prepare further pages when new varieties appear on the Lists Since it is primarily intended for use by inspectors of seed crops for identification purposes, the greater part of the information is concerned with the detail of the inflorescence and grain. Excellent explanatory diagrams showing the main recognition characters, and a glossary of the more important botanical terms are included to help the less highly trained reader The publication should also be valuable as a general reference book, for under the heading "General Information" a brief account is given of the origin of each variety and its properties, such as maturity date, disease resistance and tendency to lodge or sprout in the ear In addition, there are comments on milling, baking, malting and brewing qualities It does not, however, attempt to replace the current leaflets of the Institute, to which reference for full particulars of the use of the varieties should continue to be made. The handbook is a convenient size, printed on good paper, with a strong, serviceable cover K. W

The Pocket Guide to Nests and Eggs

By R S R. Fitter, assisted by the Hon. Guy Charteris Pp xv+172+48 plates (London. William Collins, Sons and Co., Ltd., 1954.) 21*s* net.

THE beginner in bird study, whether young or not so young, has no lack in these days of books to help him on his way. This book is frankly for the tyro, to whom it should be of considerable assistance, but experienced field naturalists will also find it of interest However, it was obviously the needs of the novice that the author had in mind, as witness the way his descriptions are divided into "Land Birds", "Waterside Birds" and "Water Birds", and each section is further subdivided into 'very short', 'short', 'medium short', 'medium', etc. Mr Fitter's descriptions of nests and eggs, in which he has been assisted by Mr Guy Charteris, are concise and accurate, while Mr R. A Richardson has supplied excellent colour plates, black-and-white plates and line drawings in the text, though the exigencies of colour reproduction have been a little unkind to the artist here and there, for example, the much too scarlet breast of the robin and the bright red flank of the redwing Nevertheless, the book should achieve its object and help the novice name the nest and eggs he discovers in the course of his rambles

Frances Pitt

FIRST OBSERVATIONS ON A LIVING CŒLACANTH

By Prof J MILLOT

Director, Institut de Recherche Scientifique de Madagascar

THE organization for the fishing and conservation of the Cœlacanths of the Comoro Islands created by the Institut de Recherche Scientifique de Madagascar, with the invaluable support of the Administration supérieure and of the Commandement de l'Air, reports a new success on November 12 last a further *Latimeria* was captured at Anjouan This brings the total since 1938 to eight and is the finest yet, as regards both size and state of preservation, and by far the most interesting because it is the first near-adult female specimen which has come into our hands as well as the first of these precious fishes which anyone has been able to observe alive, for although an Italian expedition claimed to have photographed one last year, at 15 metres depth, the circumstances were quite incredible.

As a matter of fact the principal objective, once an adequate number of specimens for anatomical investigation had been acquired, was to capture a living one and keep it alive sufficiently long to make the biological observations desired This was a difficult proposition Hitherto, almost as soon as the fish had been brought to the surface, the fishermen had promptly battered it to death with oars or dispatched it with harpoons or knives in order to prevent it from struggling, and to be able to hoist it into their narrow pirogue without too much trouble We had to put a stop to this deplorable behaviour and, on the contrary, persuade them to do their utmost to bring the fish, alive and uninjured, to the nearest harbour This they were never willing to attempt, fearing, not without good reason, that on the way a shark or a shoal of barracuda might wrest their prize from them and lose them the promised reward It took a great deal of persuasion to obtain their compliance, with an express promise that should they be successful the reward would be doubled

We, for our part, had to ensure a prison containing a sufficient quantity of sea water for the captive fish At first the provision of a fishpond on the seashore was considered, but on these rugged shores the work of constructing one would certainly be difficult That solution had, besides, the inconvenience of creating a predetermined and immovable rendezvous although the place of the next capture could not be foreseen Used as a kind of aquarium, a sunken small boat seemed to have many advantages to commend it—cheapness, simplicity, rapid installation, mobility—and it was decided to adopt this course.

The eighth *Latimeria* was pulled in from 140 fathoms depth (255 metres) at 20.00 hr. on November 12 by a fisherman, Zema ben Said Mohamed, assisted by Madi Bacari, both of the Maijihari quarter of Mutsamudu Their pirogue was then about 1,000 metres offshore, opposite Mutsamudu jetty. The sea was very calm and the tide ebbing, it was two days after full moon and the moon had just risen.

By the way in which the fish had taken the bait, the usual hunk of 'roudi' (*Promethichthys prometheus* (Cuvier)), Zema, an excellent fisherman, immediately guessed that it must have been a Cœlacanth Nevertheless, he took half an hour and every precaution over hauling it in and, having made sure that it
really was a *combessa* (the local name for the fis
he decided to try for the double reward by keep
it alive He succeeded, "en le tenant par la main",
he said, in passing a cord in through its mouth a
out through the gill-opening, and by means of t
cord and of the line (which remained attached to
centre of the anterior part of the floor of the mou
he led the creature all the way back to Mutsamu
jetty, though sometimes it was the fish that tow
the pirogue.

Administrateur Lher, as soon as he had b
notified (it was by then 20 50 hr.), decided, as we
agreed in advance, to sink a whaler immediately
which to place the *Latimeria* and keep it under
least unfavourable conditions practicable
receptacle was ready by 21 30 hr and anchored a
few tens of metres off the end of the jetty
basin of sea water so contrived measured ab
7 metres long by 1½ metres wide and 80 cm. de
The bung had been removed from the bottom
the boat, so as to provide a small but continu
current of water Besides this, every half-hour
boat was violently rocked in order to renew
greater part of the water A net covered the top
the whaler to prevent the Cœlacanth from escap
which it never seemed to want to do The green
yellow luminescence of its eyes was very pronoun
and could be seen at quite a distance The col
of the fish was very dark greyish-blue, recalling t
of the steel of a watchspring, with fins having clea
grey-bluish reflexions

Throughout the night—which the delighted po
lation of Mutsamudu passed in singing and danc
to celebrate the capture—the Cœlacanth
watched over with admirable care by the chef
circonscription, taking turns with his adjoint,
Solère. It seemed, although quite bewildered at
sequel to its ascent to the surface, to be taking
situation very well, swimming slowly by curi
rotating movements of its pectoral fins, while
second dorsal and anal, likewise very mobile, ser
together with the tail as a rudder

After daybreak it became apparent that the lig
and above all the sun itself, was upsetting the anim
very much, so several tent canvases were put o
the boat to serve as some kind of protection
despite this precaution and the more or less const
renewal of the water, the fish began to show m
and more obvious signs of distress, seeking to conc
itself in the darkest corners of the whaler

At 14 45 hr. it was still swimming feebly, but
15 30 hr it had its belly in the air and only the f
and gill-covers were making agonized movements

It was then covered with a sheet and tak
immediately to the hospital. There was not a scra
on it, apart from a tiny incision in the centre of
anterior part of the floor of the mouth made by
fisherman when recovering his hook Altogether
was in remarkably good condition, without a
rupture of the viscera or suffusions of blood.

It measured 1·42 m in length and weighed 41 kg

Chemical and histological investigations could
made under the best possible conditions on perfec
fresh tissues

Notified by telegraph of the capture and rushed from Tananarive by a special aircraft, I arrived just in time to witness the last moments of the fish

Two principal conclusions emerge from the corroborated statements made by local observers and by myself (1) the extreme photophobia of *Latimeria*—the sunlight seemed literally to hurt it, (2) the exceptional mobility of the pedunculate fins, correlated with the wealth of musculature which is revealed by anatomical studies The pectorals, in particular, can move in almost any direction and show themselves capable of assuming practically every conceivable position.

There can be no doubt that death was brought about by decompression combined with rise in temperature The previous water-samples taken by Menaché (1953) and by Millot and Cousteau (1954) n the precise positions in which previous captures had been effected showed important temperature differences between the stratum frequented by the Cœlacanths and the surface water (26° C., more or ess) during the daytime off Moroni or Mutsamudu.

It must also be noted that the *Latimeria*, which appeared greatly distressed on its arrival at the surface, seemed to have recovered appreciably after an hour or so and passed the rest of the night quite comfortably without any too obvious inconvenience It was daybreak, with the appearance of sunlight and the gradual warming of the water, which initiated the progressive discomfort that led rapidly to its death

The trial having thus been made under satisfactory conditions, it does not seem likely that substantially better results can be anticipated from the employment of the same technique in future We must be prepared to make other arrangements. The only procedure offering any hope of keeping a live Cœlacanth for a longer time would seem to be the construction of a great trellis-work cage in which we could place the fish immediately after its capture, here we should keep it normally submerged at a depth of 150–200 m., and only haul it up for limited imes when someone wanted to observe or photograph he animal Such a cage will be put in hand at Anjouan.

[Translation by Denys W Tucker, British Museum Natural History).]

NUTRITIVE VALUE OF BREAD

THE controversy about the relative values of 'brown' bread and 'white' bread seems to be ternally with us, largely due to the failure of the rotagonists on either side to appreciate that neither brown' nor 'white' is constant in composition and, till more important, that bread is rarely the only em in the diet. The nutritional value of a diet is, f course, determined by the total mixture of items n it, and their combined ability to meet the particular needs of the individual concerned These eeds are also not constant but vary according to ge, sex, activity, body-size phase of development, ate of health, past history of the organism and resent environmental conditions Very few workers rovide sufficient data about these various factors to ermit valid comparisons between the results of one xperiment and another, and it is a great pleasure o read the careful and closely argued report now resented by Widdowson and McCance dealing with the work they undertook in German orphanages after the Second World War*.

Five different flours were used (1) 100 per cent extraction, (2) 85 per cent extraction, (3) 70 per cent extraction, (4) 70 per cent extraction enriched with thiamin, riboflavin, nicotinic acid and iron up to the level of whole wheat flour, and (5) 70 per cent extraction enriched with these four nutrients up to the level of 85 per cent extraction flour All five were fortified with calcium carbonate In one orphanage the flour (mainly in the form of bread) provided approximately 75 per cent of the total calories, in the other it provided only 35 per cent, extra fat and sugar being given to provide another 35 per cent, and the residue of the diet, in both cases, being made up from the German rations provided locally. In addition, all children were given daily vitamin supplements consisting of 2,000 i u. of vitamin A, 1,000 i u of vitamin D and 25 mgm. of ascorbic acid

Some three hundred children were involved (both boys and girls) between the ages of four and fifteen, and the experiments continued throughout one complete year Many different observations were made, and a large number of chemical analyses were undertaken The authors state that "During the preliminary period, before the main experiments began, measurements of height and weight and of the girth of various parts of the body were made Each child was examined clinically, and a sample of blood was taken for the determination of hæmoglobin, hæmatocrit, serum protein and serum P-cholinesterase Radiological examinations were made of the gastro-intestinal tract and of the bones, and the teeth were inspected The children were weighed and measured every fortnight while the experiments were in progress, and they were examined clinically every three months At the end of the experimental year all the examinations which had been made at the beginning were repeated Studies of the intakes and excretions of nitrogen, minerals and of the B vitamins were also made on some of the children at intervals during the investigation".

The usual difficulty of a long-term experiment arose, namely, that individual children dropped out from time to time and so reduced the value of the initial matching of the different groups. The effects have, however, been carefully checked by various devices, and the authors are satisfied that it has not in any way invalidated their results

The two most important general findings were (1) that all the children did remarkably well, and (2) that no differences either in growth or in health could be detected between the groups receiving the different types of flour This, of course, does not mean that one flour is necessarily as good as another but merely that, in this series of experiments, one diet was (apparently) as good as another The qualification is necessary because there was some evidence that the children on the low bread diets (35 per cent of the total Calories) tended to become too fat, whereas the high bread diet produced a better all-round development The authors themselves say "The advantages of the [high-bread] diet would probably have become more obvious as the children approached maturity and might be still more striking in adult life".

---

* Studies on the Nutritive Value of Bread and on the Effect of Variations in the Extraction Rate of Flour on the Growth of Undernourished Children By E M Widdowson and R A McCance Medical Research Council, Special Report Series No 287 Pp viii+137+1 plate (London H M Stationery Office, 1954) 8s 6d net

At the beginning of the experiment the children were under-developed by comparison with American children of the same age , but during the experimental year they grew at a greater rate and so decreased the differences. In spite of this stress of abnormally rapid growth, no signs of specific vitamin deficiencies were detected in any group at any time, and radiological examination showed that bone development kept pace with the rapid increases in height and weight The only unsatisfactory finding was the prevalence of slightly enlarged thyroid glands, which persisted despite dosage of small amounts of iodine The authors suggest that this may have been due to the high calcium intake. It is perhaps also possible that the diet included goitrogenic vegetables

In general, however, it is clear that, on these diets, previously under-nourished children were able to make very satisfactory progress At the end of the year, a supplementary trial was run and a group of children in the first home were given 500 ml of reconstituted full-cream milk daily for six months This produced no detectable difference in growth-rate or physical condition from the control group, which continued on the previous high-bread diet.

Several commentators have already expressed surprise that the diets used should have produced such good results, and the authors themselves seem to have expected something different. Yet, in both homes, the diets were considerably better than most children throughout the world normally grow up on, and there does not appear to be any need for revising our conception of requirement levels as a result of this work

The diets were made up in the following way

Daily intake (gm)	No. 1	No. 2
Flour—		
100 per cent extraction	447	250
or 85 per cent extraction	437	—
or 70 per cent extraction	418	240
Potatoes	168	257
Fruit and vegetables	112	160
Meat, fish, cheese	24	34
Milk (mostly skim)	82	113
Butter and margarine	12	91
Sugar and jam	58	101

The children were able to eat to appetite and they averaged 2,000–2,500 Calories per head per day In the first diet, animal protein averaged 8–9 gm , but total protein ranged from 61–73 gm. , in the second, animal protein averaged 11 gm and total protein 51–55 gm In the first diet, fat averaged 22–29 gm as against a pre-war average of 92 gm. for British children. Even so, however, it was considerably higher than the amounts commonly obtained by children in many under-developed parts of the world

Ascorbic acid and vitamins A and D were maintained at a high level by the special vitamin supplements, and calcium by the addition of creta præparata (at varying levels) to all grades of flour used. Such supplementation is, of course, not normally available in other countries. The authors seem to think that the satisfactory bone and tooth development might not have been achieved without these supplements, and they point out that these may also explain the failure of the milk supplement to produce any further improvement, since "the present investigation is, in fact, the only one in which a milk supplement has been added to a diet known to contain plenty of calcium and vitamin D".

Increasing the refinement of flour (lowering the extraction-rate) primarily affects the values for iron, thiamin and nicotinic acid, and it is in relation to one of these that some evidence of deficiency might have arisen in the group receiving the refined flo The most common defect of high cereal diets in oth parts of the world, namely, a deficiency of riboflavi might also have been expected in the high-bre group with their lower intakes of milk, meat a vegetables Biochemical tests, however, showed th supplies of B vitamins were sufficient, but "t margin of reserve appeared to be small in the ca of the children eating unenriched white bread. T supplies of riboflavin were probably nearest to t margin of safety"

An important and unfortunate aspect of this wo is that the 70 per cent extraction flour that was us had a vitamin content above average for this type flour Had this not been the case, deficiency sig might well have appeared Failure to appreciate th point will inevitably lead to unwarranted deductio being drawn from the findings presented in th report, despite the continually reiterated warnings the authors In fact, the results of these experimen amply confirm the wisdom of the Post-War Lo Conference[1], which recommended that extractio rates should not be permitted to fall below 80 p cent, and that an 85 per cent level was to preferred.

The report contains a section dealing with t results of feeding the diets to laboratory anima and several valuable appendixes by different autho setting out the detail of the biochemical and radi logical investigations. M W GRANT

---

[1] Report of the Conference on the Post-War Loaf Cmd 67 (H M S O , 1945)

A MANDIBULAR FRAGMENT, PROBABLY OF THE SALDANHA SKULL

By Prof M R. DRENNAN and Dr. R SINGE

University of Cape Town

IN reconstructing the Saldanha skull-cap (s *Nature*, 172, 791 ; 1953), a few small fragmen were temporarily left out, because we did not ha all the pieces necessary to complete the 'jig-sa puzzle'.

Among these fragments was part of the ramus a mandible with the coronoid process on it , but colouring, especially on its inner aspect, differed fro that of the skull fragments, although the degree fossilization appeared to be identical It looked huma but it was somewhat out of the ordinary, and extra measure of caution in identifying it was nece sary, especially as it was found 500 yards away fro the main fragments of the Saldanha skull[1]

Closer inspection has now convinced us that t specimen is human, and we consider that it probab belonged to Saldanha man. It has a morpholo appropriate to the skull, and, by a coincidence, small piece of human parietal bone was found w it. Both pieces were collected by one of us (R. S), a it so happens that the parietal fragment had recently cracked edge which fitted perfectly corresponding fracture on the Saldanha skull

The remarkable feature of the mandibular fra ment is that it is almost identical in shape a dimensions to the corresponding part of the Mau jaw (Heidelberg mandible) (Fig 1) This latter ja is by far the oldest of the strictly human fossils, a

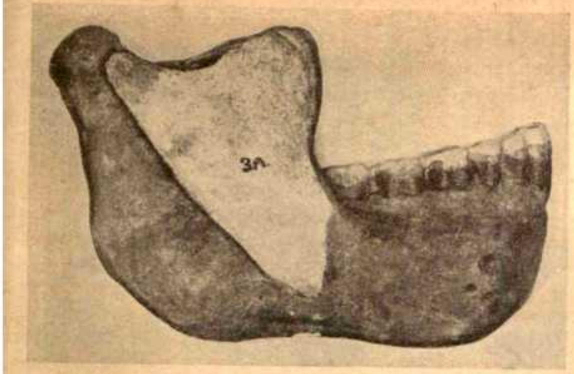


Fig. 1. The Saldanha mandibular fragment (3A) superimposed on a cast of the Heidelberg mandible

its massiveness and primitive features have kept it for long as an isolated enigma.

There has never been any doubt about the great evolutionary importance of this human prototype, and it is particularly interesting from the South African point of view, where the proportions of the square gibbon-like ramus of this mandible survive in a range of sizes in Bushman, Hottentot and pre-Khoisan jaws. For this reason we have less hesitation in reporting that our evidence, albeit precariously limited, suggests that Saldanha man possessed a counterpart of the Mauer jaw.

While commenting on the large size of the masticatory apparatus of Rhodesian man, the late Sir Arthur Keith[2] pointed out that the width of jaw which this skull required was identical with that supplied by the Mauer jaw; and he might also have added that the huge upper dental arch of the Rhodesian skull requires an even bigger arcade of lower teeth than the Mauer jaw exhibits. There was every likelihood, therefore, that the Rhodesioid Saldanha skull would have a Mauer-like jaw.

Owing to the incompleteness of this ramus, only one of the conventional measurements is available for comparison. This is the important one of the height of the coronoid process above the alveolar plane, the level of which can fortunately be located from the impression on this fossil of the posterior root of the third molar tooth (Fig. 2). This height measurement is 40 mm. in both the Saldanha fragment and the Mauer jaw.

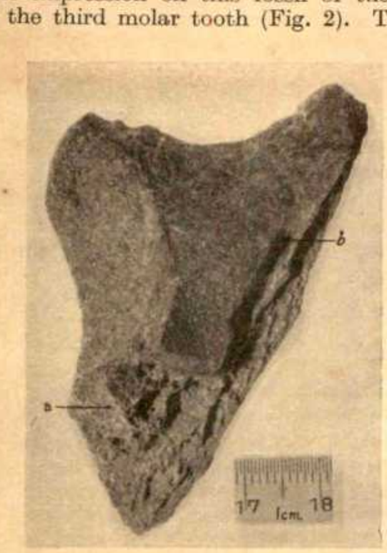


Fig. 2. Lingual aspect of the mandibular fragment, indicating posterior root socket of lower third molar (*a*), and the position of the mandibular foramen (*b*)

The ramus is fractured diagonally about half a centimetre behind, and parallel to, the inferior dental canal, so that it has been necessary to estimate the width of the ramus. For this, however, good guidance is available from the mandibular foramen, which is shown on the inner side of the specimen (Fig. 2). This opening for the nerve to the lower teeth occupies a fairly constant position relative to the borders of the ramus in jaws of similar type. In our collection of Bushman mandibles, there is an average of 59 per cent of the width of the ramus in front of the opening and 41 per cent behind it, and the same proportions are found in the Mauer jaw. By using these proportions, we estimate the width of the ramus of our specimen to have been approximately 49 mm. This is only 2 mm. less than the width of the Mauer ramus, and this small difference does not materially alter the fact that there is a close typological correspondence between them.

Our fragment is, however, definitely less robust than the corresponding part of the Mauer jaw. This is not unexpected when one considers that, old as both fossils are, the Heidelberg one dates from the beginning and the Saldanha one from towards the end of Chelles-Acheulean (handaxe) times.

The interesting thing is that, while in Europe there is evidence (Swanscombe and Fontéchevade skulls) that man evolved into a sapient type during that long epoch, Saldanha man, on the other hand, has apparently remained typically palæoanthropic in both skull and jaw.

[1] Singer, R., *Amer. J. Phys. Anthrop.*, n.s., **12**, No. 3, 345 (1954).

[2] Keith, A., "The Antiquity of Man", **2**, 397 (Williams and Norgate, London, 1929).

DISLOCATIONS, WORK-HARDENING AND CREEP*

By Prof. N. F. MOTT, F.R.S.
Cavendish Laboratory, Cambridge

MY aim in this lecture is to describe in outline the present state of the theory of work-hardening of metals and to propose some new ideas about recovery and creep. What I shall say is based on the theory of dislocations, and indeed is derived very closely from G. I. Taylor's[1] classic paper of 1934. In that paper, Taylor ascribes the resistance to flow or hardness of a metal to the interaction between dislocations; as the metal is deformed, more and more dislocations are formed, so that work-hardening can be ascribed to the increase in this interaction as the strain is increased. At the time that Taylor's paper was written, no model existed to account for the formation of dislocations as a consequence of strain; a model for this purpose was proposed by Frank and Read[2] in 1950 and is now generally accepted, though up to now no direct experimental evidence for its validity has been obtained. The model assumes the presence in an annealed metal of a dislocation network such as that observed in silver bromide by Hedges and Mitchell[3], and shows that each element of the network can act under a low stress as a source of dislocation rings. It thus gives an unforced explanation both of the low yield-stress of annealed crystals and of the localization of slip on a few active slip planes.

---

* Substance of a lecture at the Royal Institution delivered on November 2.

The localization of slip on active slip planes makes it difficult to explain work-hardening if one assumes that it is here on the active slip planes that the dislocations are. Slip bands observed under the optical microscope are normally about a micron apart. One can scarcely imagine the material between active slip planes to be free of Frank–Read sources. In a material that has been strained, then, one has to ask why these sources have not generated dislocations. Their interaction with dislocations on the slip lines one micron away would be at least a hundred times too weak to stop them. To solve this dilemma, I suggested[4] that dislocations are formed in the surrounding material, too ; I pointed out that in the slip lines we may have to do not only with single dislocations but also with large piled-up groups and that the stress around these groups would be large enough to produce some flow in all parts of the cold-worked crystal.

While some secondary flow of this kind may occur, the observations of Wilsdorf, Van der Merwe and Kuhlmann-Wilsdorf[5] suggest that the solution of the difficulty is more simple ; using the electron-microscope and a silica replica, they observe fine slip lines about 200 A. apart, 50 A. high and 10 microns long filling the space between the 'coarse' or visible slip lines or bands. One may assume that these fine slip lines, too, are due to the production of dislocations by Frank–Read sources, and that the dislocations so formed are responsible for hardening the material between the slip bands. Although fine slip may account for as little as ten per cent of the total deformation, it is the dislocations produced by fine slip which must account for the resistance to flow of the weakest part of the material, namely, that between the coarse slip lines. It is the fine slip, therefore, which, according to these ideas, determines the stress-strain curve.

Following and extending the ideas of Wilsdorf and Kuhlmann-Wilsdorf, we may treat the hardening quantitatively as follows : let S and S' in Fig. 1 be two sources which are giving out dislocations at the same time. Let the intersections SX, $S'X'$ of their slip planes with the plane of the paper be at a distance d from one another. Then if the applied stress S is great enough to push a pair of dislocations such as PQ past each other, an arrangement such as that shown in Fig. 1 will result. When the stress is taken off, P and Q will form a doublet and stay together owing to their mutual attraction, as will also P' and Q' and so on. The arrangement is therefore stable. Work-hardening results as d decreases through the formation of more and more fine slip lines, the flow stress S being given according to the authors cited by

$$S = Gb/8\pi(1 - \mu)d$$

Here G is the shear modulus, b the Burgess vector and μ Poisson's ratio. Among the dislocations which result from fine slip we do not envisage anything in the nature of piled-up groups.

Coarse slip may be due to a kind of instability in the mechanism for the formation of fine slip. If one Frank–Read source produces an excess of dislocations which are unpaired with those from any other source, as in Fig. 1(*b*), a piled-up group will form, which could push its way past the dislocations on neighbouring active fine slip planes, so that more and more dislocations are produced from this particular source.

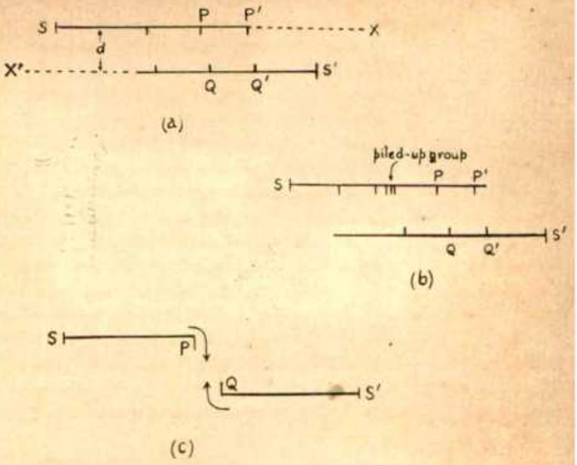


Fig. 1

(*a*) Arrangement of dislocations in fine slip
(*b*) Mechanism for the formation of coarse slip lines
(*c*) Disappearance of dislocations by climb or cross-slip during creep

We have no detailed model for the hardening within a coarse slip band ; perhaps the arrangement is similar to that of Fig. 1, but with a longer slip distance and more dislocations. But there are two reasons for believing also that piled-up groups are formed. One is that polycrystalline metals do eventually fracture in a tensile test ; as Stroh[6] and I[7] have pointed out, the most natural stress-raiser at which fracture can begin is the piled-up group at the end of a slip line. The other is the broad slip lines observed in fatigue in polycrystalline copper by Wadsworth[8]. An example (at present unpublished) is shown in Fig. 2. The subsidiary slip which occurs here and there at about 45° to the main line looks as though it were due to local stresses around piled up groups.

Whatever the mechanism of hardening in the coarse slip line, our point remains that if there is no fine slip there should be very little hardening. Thi prediction seems in fact to be in agreement with observations of the deformation of crystals of alpha brass. The observations of Wilsdorf[5] for this meta show that there is no fine slip ; a model due t

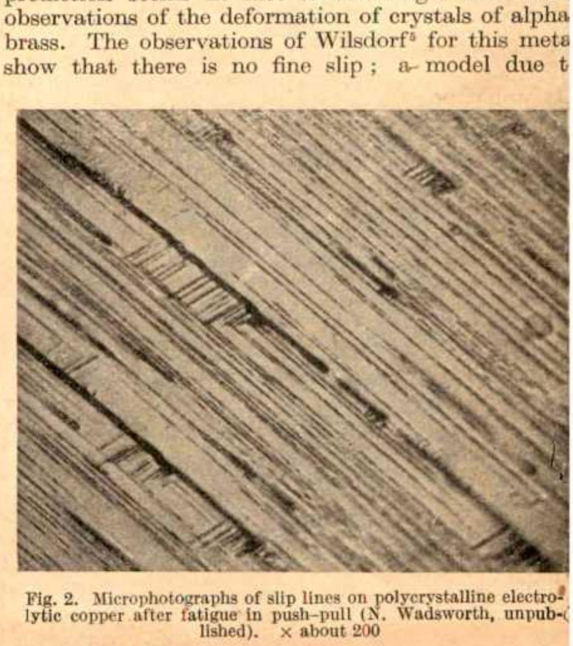


Fig. 2. Microphotographs of slip lines on polycrystalline electrolytic copper after fatigue in push–pull (N. Wadsworth, unpublished). × about 200

Fisher[9] explains this, showing that in solid solutions a source which has once started to generate dislocations has a tendency to continue. But the interesting point about alpha-brass is that, so long as slip is confined to one set of planes, there is very little hardening, coarse slip does not, it seems, harden the intervening material[10].

As shown particularly by Andrade's group[11] and by the work of the Gottingen school[12], work-hardening proceeds more rapidly in single crystals when slip occurs on more than one plane, though the observations relate to the coarse slip only This we suppose to be due to the mutual locking which, according to the ideas of Cottrell[13] and Lomer[14], can occur when two dislocations in different glide planes interact. This will shorten the slip distance, so that more dislocations will be produced by a given deformation.

Cold-worked materials, as shown, for example, by the experiments of Hirsch and his colleagues[15], show a cellular or polygonized formation, the size of cells being about the same as the distance between the (coarse) slip lines. This seems to us to follow naturally from the model · the material in the cells will be full of pairs of dislocations due to fine slip, but the coarse slip bands, if the amount of slip on a band varies along its length, is bound to lead to a bending of the material between them This bending gives rise to an excess of dislocations of one sign, and it is these that polygonize and form the walls of the cells.

We turn now to a discussion of creep, and with this model we may ask what is the rate-determining process, in any event in creep under constant stress when the rate of strain has settled down to a constant value. In experiments on pure metals such as those of Wood[16] and of McLean[17], what one observes is the breaking up of the grains into sub-grains. This we believe to be a consequence in polycrystalline material of the bending of the individual grains which must occur[18] during strain and the subsequent polygonization. It is not in our view likely to be the rate-determining process, this will be the plastic deformation of the sub-grains. Further, since the creep under discussion is at a steady rate, and no work-hardening is taking place, the process must be envisaged as shown in Fig 1 (c) Two sources give out dislocations which move into one another's neighbourhood and then annihilate each other Annihilation can occur by 'climb' in the case of edge dislocations, or by 'cross slip'[19] in the case of screws. It would be of great interest to know whether the dislocations in cold-worked metals are mainly edges or screws. It has frequently been suggested that the dislocation rings given out by Frank–Read sources should be very oblong and mainly of screw type, because of the high stress believed necessary to move a screw dislocation containing jogs. To find out whether this is so, one needs to examine the lengths of the fine slip lines on the top and side surfaces of a strained single crystal, this is a key experiment that ought to be done.

It may be that the annihilation by climb of dislocations such as P and Q can be the rate-determining process in creep. If so, and if the mean distance between jogs along these lines is less than the distance PQ, the activation energy for creep ought to be the same as for self-diffusion and ought not to depend on stress. A recent report by Dorn[20] suggests that this may be so. On the other hand, there is much evidence that, particularly in technical creep-resisting materials, it is slip rather than climb, or self-diffusion, which determines the rate of strain. Materials in solution above the limit of solubility, which slowly diffuse to the dislocations and form atmospheres there in the way proposed by Cottrell[21], are obviously able to impede slip, but scarcely to impede climb. One wonders whether the slow motion of dislocations from points such as S to P is perhaps not the rate-determining process in such metals, their disappearance then always taking place quickly enough to prevent the accumulations of dislocations that we call work-hardening.

If so, it is possible to propose a mechanism for a temperature-dependent movement of dislocations which seems to account for many of the observed facts of creep in pure metals As mentioned above, the screw elements of dislocation rings are the ones which will find it hard to move, because when they contain jogs they leave behind them a row of vacancies. A screw dislocation can only move forward with the help of temperature if each vacancy produced moves away as soon as it is formed; if it remains *in situ* it will pull the dislocation back. As I have shown[22] in a paper contributed to the recent conference on creep at the National Physical Laboratory, the rate of movement of a screw dislocation under a stress S and at a temperature T might be expressed by a formula of the type:

$$\nu l \exp \{ - (W - b^2 lS)/kT \}$$

ν is here an atomic vibrational frequency, l the distance between jogs, and W the energy for self-diffusion. This is the type of formula that many authors (for example, Feltham[23]) use in expressing creep results, with an activation energy that drops sharply with stress The divergence between these results and those of Dorn, who uses a formula of the type

$$\text{const.} \exp \{ - (W/kT) - \beta S \}$$

represents a point of great interest for the theory of creep, though it is difficult to be sure in experiments at different temperatures that l will be the same.

Another point which has been emphasized by Seeger[24] is that the energy of a jog is much greater in copper than aluminium, so that climb will be slower than in the former metal. The rapid recovery of cold-worked aluminium may perhaps be associated with this fact.

[1] Taylor G I, *Proc Roy Soc.*, A, 145, 362 (1934).
[2] Frank, F C, and Read, W T, *Phys Rev*, 74, 722 (1950)
[3] Hedges, J M, and Mitchell, J W, *Phil Mag.* (7), 44, 233 (1953)
[4] Mott, N F, *Phil Mag* (7), 43, 1151 (1952)
[5] Kuhlmann-Wilsdorf, D, Van der Merwe, J H, and Wilsdorf, H, *Phil Mag*, 43, 632 (1952), *Acta Metallurgica*, 1, 394 (1953)
[6] Stroh, A N., *Proc Roy Soc*, A, 223, 404 (1954).
[7] Mott, N F, *Proc Roy Soc* A, 220, 1 (1953)
[8] Wadsworth, N J, and Thompson N, *Phil Mag* (7), 45, 223 (1954).
[9] Fisher, J C, Report to Bristol Conf Phys Soc (1955)
[10] von Göler, F, and Sachs, G, *Z Phys*, 55, 581 (1929) Madden, R, Mathewson, C H, and Hibbard, W R, *Trans Amer Inst Min Met Eng*, 175, 86 (1948)
[11] Andrade, E N da C, and Henderson, C, *Phil Trans*, A, 244, 177 (1951)
[12] Lücke, K, and Lange, H, *Z Metallk*, 43, 55 (1951)
[13] Cottrell, A H, *Phil Mag* (7), 43, 465 (1952)
[14] Lomer, W M, *Phil Mag* (7), 43, 1327 (1951).
[15] Gay, P, Hirsch, P B, and Kelly, A, *Acta Cryst*, 7, 41 (1954).
[16] Gough, H J, and Wood, W A, *Proc Roy Soc*, A, 154, 510 (1936), 165 359 (1938)
[17] McLean, D, *J Inst Metals*, 80, 507 (1952), 81, 287 (1953)
[18] Boas, W, and Ogilvie, G. I, *Acta Metallurgica*, 2, 655 (1954)
[19] Mott, N F, *Proc Phys Soc Lond*, B, 69 729 (1951).
[20] Dorn, J E, Proc N P L Creep Conf (H M S O, 1955).
[21] Cottrell, A H, "Dislocations and Plastic Flow in Crystals" (Oxford, 1951)
[22] Mott, N F, Proc N P.L Creep Conf (H M S.O, 1955)
[23] Feltham, P, *Nature*, 169, 976 (1952)
[24] Seeger, A, *Z Naturforsch*, 9a, 758 (1954)

OBITUARIES

Prof. P J Heawood, O B E

Percy John Heawood died in Durham on January 24 in his ninety-fourth year. Educated at Ipswich and at Exeter College, Oxford, he taught mathematics at Durham, first as lecturer and then as professor, for fifty-two years, from 1887 until 1939. His early promise as a mathematician was to some extent thwarted by the width of other interests—religious, intellectual and administrative—which he pursued throughout his academic career at Durham, but he published a paper in his ninetieth year on the four-colour problem, more than sixty years after his first published work on that subject He held in turn almost every administrative post in Durham, culminating with a two-year term as vice-chancellor in 1926–28 His loyalties were strong, and the strongest was for Durham, where his great memorial will be the Castle, once more standing firm and safe above the River Wear. When it began to slide down the cliff, the University spent all its available resources and despaired of finding the vastly greater sum needed Almost alone, Heawood would not despair, and as secretary of the Castle Preservation Committee toiled year after year until the newly founded Pilgrim Trust came to the rescue with a very large grant.

Heawood was almost extravagantly unlike other men, in appearance, mannerisms and habits of mind. An immense moustache, an extremely loud voice, and a long cape of strange pattern and manifest antiquity made him conspicuous to eye and ear. He set his watch once a year, on Christmas Day · "No, it's not two hours fast, it's ten hours slow". All his life was organized on equally logical but fantastic lines Long before he was distinguished by longevity, legends had clustered thick about him. He did not cultivate his reputation as a character. He just went his way and did not care whether people laughed. But this comic side was by no means the whole man Together with some prejudices and some limitation of sympathies, he was interested up to extreme old age in many sides of the contemporary world, he could be lively and humorous as a speaker, and was an excellent chairman at meetings, for which he had a singular passion He read Latin, Greek and Hebrew all his life with real appreciation. His transparent sincerity, piety and goodness of heart, and his extraordinary blend of naïveté and shrewdness, secured to him not merely the fascinated interest, but also the respect and indeed the affection, of his colleagues. Latterly he was indeed a Nestor in Durham. He had been teaching there for some years before the oldest member of the present Senate was born.

James Duff

Dr. C. H. Hampshire, C M.G.

Charles Herbert Hampshire, secretary of the British Pharmacopœia Commission during 1929–50, died in London on January 25 at the age of sixty-nine He was born at Ilkley, and in 1905 entered the School of the Pharmaceutical Society with a Jacob Bell scholarship and there showed great promise. He gained most of the prize medals of his year, qualified as a pharmacist and later joined the staff and took a London honours degree in chemistry. An early intention to follow a career in teaching was abandoned in 1914 when he was appointed chief pharmacist at University College Hospital, London, a post which he held until 1929. During this period he became a student in medicine, not with the intention of taking up medical practice but in order to fit himself for the expanding responsibilities of the pharmaceutical department of a teaching hospital. He obtained the Conjoint diploma in 1925 and the M.B., B S. of London in 1927.

These earlier phases of Dr Hampshire's career proved their value when, in 1929, he was appointed secretary of the British Pharmacopœia Commission, a body newly created by the General Medical Council on the advice of the Macmillan sub-committee of the Committee of Civil Research. He developed the permanent organization to serve the work of succeeding Commissions in the evolution of a modern pharmacopœia, and his twenty-one years of office saw the "British Pharmacopœia" achieve a standard which is respected throughout the world. He was responsible for a new edition in 1932 and, after the issue of six war-time "Addenda", he dealt with another edition in 1948. To this complicated work he brought unstinted energy and wide knowledge.

Early in his career Dr. Hampshire became interested in the development of an international pharmacopœia and in 1937 was appointed chairman of the Technical Committee of Pharmacopœial Experts set up by the League of Nations, after the War he was called upon to preside over the Expert Committee on the Unification of Pharmacopœias appointed by the World Health Organization. In 1951 he was able to present the first volume of the "Pharmacopœa Internationalis" to the assembly of the Fédération Internationale Pharmaceutique in Rome, and to the end of his life he continued his work on the preparation of further volumes.

He will be remembered chiefly for his major achievements as a pharmacopœial expert, but he gave long and devoted service to other aspects of pharmacy and medicine. He was editor of the *Quarterly Journal of Pharmacy and Pharmacology* from 1928 and continued in office when it became a monthly publication in 1949. He was chairman of the British Pharmaceutical Conference during 1932–34, and for many years a member of the board of examiners of the Pharmaceutical Society and of the Royal Institute of Chemistry, of which he was a Fellow. In 1949 he was made a Companion of the Order of St. Michael and St. George. By Dr. Hampshire's death international pharmacy has been deprived of one of its most distinguished figures, and British pharmacy has lost a dignified and devoted servant.

T C. Denston

Lord Charnwood

Lord Charnwood, who died on February 1 at the early age of fifty-three, and who made some notable contributions to the study of physiological optics, and particularly binocular vision, was the son of the first Baron Charnwood and Dorothea May Roby A product of Eton and Balliol, he later trained as a mechanical engineer, becoming the chief engineer of Bamford-Martin, the original makers of the Aston-Martin car. During the War he became interested in problems connected with the training of range-takers, using stereoscopic range finders. This gave him his first opportunity of carrying out experimental work on vision. Eventually he qualified as an ophthalmic optician, becoming a Fellow of the

British Optical Association, and afterwards an Honours Fellow of the Worshipful Company of Spectacle Makers

He practised in London and joined the staff of the London Refraction Hospital, where much of his research work was carried out. Lord Charnwood was the first recipient of the new higher diploma of the Worshipful Company of Spectacle Makers, and was awarded the Master's prize for his thesis on binocular vision He was awarded an honorary diploma in orthoptics by the British Optical Association in 1952, and the Research Medal of that body in 1954.

He was also a lay Fellow of the Royal Society of Medicine, a Fellow of the Physical Society, and of the Royal Microscopical Society. He was a Fellow of the American Academy of Optometry, and had lectured widely in the United States. His output during these eight years was outstanding, as the following will show

Lord Charnwood described his research as a "record of unrelated small attacks on a number of facets of the problem of how the brain contrives to drive the two eyes in double harness". His most important work was probably his "Essay on Binocular Vision", published in 1950, but his paper on 'Retinal Slip", read at the International Optical Congress in 1951, and reported in the *Transactions*, was of an equally high standard. Other work carried out by him was described in a number of contributions between 1947 and 1952. These included "Some Anomalies of Binocular Vision", a paper read at the London Refraction Hospital Congress, 1947, and "Notes on Prolonged Occlusion" (*Optician*, August 8, 1947), following Marlow's work on this subject This was afterwards extended to include the treatment value of occlusion in binocular imbalance, described in a paper, "The Diagnostic and Therapeutic Use of Monocular Occlusion" (*Brit J Physiol Optics*, January 1951), and a number of papers in *The Optician*, including one on the "Mathematical Analysis of Binocular Vision" (Jan. 30, 1948).

An interesting and unusual contribution was his "Influence of Alcohol on Fusion" (*Brit J Ophthalmology*, 1950), in which he demonstrated the reduction of the fusional reserves under the imbibition of alcohol, and suggested that some comparable intoxication might be the means whereby such illnesses as measles and whooping cough precipitate squints. He had a communication in *Nature* of August 26, 1950, on the "Effect of Posture on Involuntary Eye Movements".

Lord Charnwood's final contributions, "Stereopsis in the Presence of Diplopia" and "Fusion in Binocular Vision", a criticism of Asher's suppression theory, were both produced in 1954 and published in the *British Journal of Physiological Optics* a few months before he died

By his death, the optical profession has lost an outstanding figure, and he leaves behind him many friends

G H GILES

NEWS and VIEWS

Zoology at Bedford College, London : Prof. N. Millott

PROF NORMAN MILLOTT, who succeeds Prof H Munro Fox in the chair of zoology at Bedford College, University of London (see *Nature*, 174, 537, 1954), is a graduate of the University of Sheffield. His early work, on the morphology and physiology of the gastropod mollusc *Jorunna*, completed during the period of his first university appointment as demonstrator in the University of Manchester, was accepted for publication by the Royal Society and its excellence recognized by the award, in 1936, of the Rouse Ball Studentship at Trinity College, Cambridge. Under the influence of the Cambridge experimental school, Prof. Millott began his investigations of the form and properties of the visceral nervous system of the earthworm *Lumbricus* and of the nervous control of secretion, the results of which were published in a series of papers in the *Proceedings of the Royal Society*. During the War, Prof. Millott served as a signals officer in the Royal Air Force and on demobilization returned to Manchester, first as a lecturer and later as a reader in zoology. When in 1947 applications were invited for the chair of zoology in the newly founded University College of the West Indies, Prof Millott, now well known as a stimulating teacher and for the originality and high quality of his research work, was selected for the important task of organizing the Department of Zoology, and, in consultation with the University of London, of devising courses suitable for overseas students taking the B.Sc. degree of London. In this he has been conspicuously successful. During his eight years in the West Indies, Prof Millott has, moreover, not only maintained his contacts with British universities but also has spent much of his vacation time visiting and working in American universities and laboratories. His experience and qualities will ensure him a warm welcome from his future colleagues in Bedford College and from fellow zoologists throughout the University of London

James Clayton Prize for 1954 : Sir Christopher Hinton, F R S.

THE James Clayton Prize for 1954 of the Institution of Mechanical Engineers has been awarded to Sir Christopher Hinton for his pioneer work in applying the results of nuclear research to the production of fissile material and industrial power, communicated in part in a lecture delivered to the Institution of Mechanical Engineers during 1954 By the terms of the will of the late Mr James Clayton, not less than one-quarter of the annual income accruing from the James Clayton Trust Fund shall be awarded as a prize to a member, associate member, graduate or student of the Institution for a contribution during the year to modern mechanical engineering science by way of research, invention or experimental work, or by a treatise or paper on a modern mechanical engineering subject , or by originality in design , or by service to mechanical engineering. The sum of £1,620 was available for the 1954 award

Expenditure by the Department of Scientific and Industrial Research

REPLYING in the House of Commons to questions regarding grants to research associations, Mr J. R. Bevins, Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the

Council, stated on January 28 that about £40,000 of the additional £91,000 allocated to research associations by the Department of Scientific and Industrial Research during the present financial year is for providing increased grants for a number of existing associations and initial grants to the Chalk, Lime and Allied Industries Research Association, the British Steel Castings Research Association and the Timber Development Research Council. The remainder is for capital grants to the Electrical Research Association and the Production Engineering Research Association. On February 1, Mr. Bevins added that in the financial year 1950–51 capital grants of £271,000 were made to research associations, in 1951–52, £53,000, in 1952–53, £17,000, in 1953–54, £2,000 It was expected to make no capital payments in the present financial year. Industries were asked to undertake to raise special contributions over and above their normal revenue contributions to the research associations, and the estimates of the total cost have to be submitted to the Department of Scientific and Industrial Research for approval He also referred to the special surveys of the resources, facilities and programmes of the leather, cast iron and ceramics research associations, which were carried out as an experiment in 1950–51, a survey of the work of the British Scientific Instrument Research Association has just been started.

The affairs of the Department of Scientific and Industrial Research were again the subject of questions in the House of Commons on February 8 Mr. Bevins stated then that only about five per cent of the Department's work is directly undertaken for defence, and that is normally paid for by the Defence Department. In a written answer, he said that the staff establishment at the Fuel Research Station in 1953–54 was 292 and the expenditure £268,535, compared with 311 and £295,550, respectively, in 1954–55. Asked for an estimate of the expenditure of the Department in terms of 1946 values, he gave the following figures for gross expenditure based on the price index for all consumer goods and services calculated by the Central Statistical Office annually.

1944–45	£1,491,000	1949–50	£3,662,000
1945–46	1,685,000	1950–51	4,019,000
1946–47	2,208,000	1951–52	4,035,000
1947–48	2,825,000	1952–53	4,085,000
1948–49	3,198,000	1953–54	4,076,000

Referring to the Geological Survey, he said that about 60 per cent of England and Wales, 90 per cent of Scotland and all Northern Ireland have been surveyed in detail, but he could not state when the survey would be completed

Earth Tremors in Quetta

A SWARM of strong earth tremors, about forty in number, starting about February 13 and continuing on February 20, has affected the district around Quetta. Damage to the water supply system and a temporary breakdown of electricity supplies and telephone communications are reported, and there has been damage to property, with some fatal casualties There is some apprehension in the district, since many remember the earthquakes of May 1935 when some twenty-five thousand people were killed

Journal of the West African Science Association

BEFORE the Second World War, some excellent scientific work was done in the British West African territories, but the number of research workers was small, they were mostly in government service with much of their time taken up in routine work, and there was little difficulty in finding an outlet for the publication of results in the existing journals Since the War, the establishment of the new University Colleges in the Gold Coast and in Nigeria, and the development and expansion of the independent research institutes dealing with trypanosomiasis, virus diseases, cocoa, oil palms, fisheries, etc, has greatly increased the volume of original work, at a time when existing journals are crowded and publication of new work is often long delayed A new publication, the *Journal of the West African Science Association* (1, Part 1, October 1954. Pp. 72+1 plate. London Charles Knight and Co, Ltd. 21*s* per vol (2 parts)), is intended to serve as an outlet for work dealing with West Africa as a whole It is well produced (printed in England), and the papers in the first number reach the standard required by most established journals They cover a wide field—the geography of Nigeria's coastline, the geology of the Achimota College cricket field, land utilization, check lists of molluscs and seaweeds, new records of flowering plants, and a review of recent work on soil fertility. It is stated that one reason for producing this new journal is that "it is convenient for research workers to have their papers on this area readily available within one journal". This can only be true to a limited extent. If reviews of interest to scientific workers generally are to form the journal's main contents that will be true, and the paper on soil fertility (by P. H. Nye) fulfils this object, but the other papers are more specialized, and it is difficult to imagine that many members of the West African Science Association will read more than one or two with interest or understanding Research as a whole is bound to be specialized, however much this may be deprecated, and by trying to cover too wide a field this journal might defeat its object. However, West Africa is developing rapidly and there is certainly room for this and more journals like it, it is probable that as it grows it will be necessary to divide it into various sections dealing with different subjects, and perhaps later on it will become the parent of a distinguished family o scientific publications.

Bulletin of the Research Council of Israel

THE Israel Research Council was set up some year ago to organize and stimulate research in all branche of science and technology and to co-ordinate th work of the many scientific institutes in the country The *Bulletin of the Research Council of Israel* is published quarterly (Jerusalem: Israel Scientific Press Annual subscription, I£4.000, 5.50 dollars) and contains original papers as well as preliminary communications in the form of "Letters to the Editor' Papers are submitted in English or French, an summaries of them are collected together at the bac of each issue, where they can be easily consulted Volume 4, No 1 (June 1954) contains nineteen papers of which several are on biochemical or chemical topics Three of these papers are contributions from America laboratories and the rest are from workers in th Hebrew University, the Israel Institute of Technology, the Weizmann Institute or other laboratorie in Israel. L. Picard, of the Israel Geological Institute has written an interesting article on the structura pattern of Palestine, and there are two papers technological interest as well as others on botanic and zoological subjects. The standard of the articles appears to be high, and the journal itself is well produced. A whole section of this issue of the *Bulletin* reports the proceedings of the Israel Chemical Society by giving adequate abstracts of the communications in inorganic, organic and physical chemistry which were delivered. There is also a biographical sketch of Prof. Andor Fodor, on the occasion of his seventieth birthday, to commemorate his long association with the Hebrew University and with the development of scientific work in Israel

Research Essay Competition

THE Scientific Advisory Board of *Research* has decided for the third successive year to organize a "Science in Industry" essay competition The purpose of the competition is to encourage scientists to take greater interest in the problem of presenting the results of scientific research work to people less highly qualified than themselves. It will be in two parts The first part aims at directing attention to the problem of the scientist in communicating with the industrial policy-maker. Often, the board of directors of an industrial firm contains no member with scientific or technical training Scientists must learn how to put forward the case for the development or investigation of some new scientific process or project in terms which a technically unqualified board can appreciate. Competitors are required to make their case in an essay of about three thousand words in length Prizes amounting to £200 are to be awarded for this part of the competition In addition, the author of the best essay will receive a special new award to be known as the Waverley Gold Medal The second part of the competition requires the scientist to discuss one of four set subjects in a manner suitable for publication in a general newspaper The prizes for this part of the competition, amounting to £150, are to be awarded by the *Sunday Times* Further information can be obtained from the offices of *Research*, 88 Kingsway, London, W C 2

Endeavour

MAINTAINING its standard of excellence, the latest number of the journal *Endeavour* (issued by Imperial Chemical Industries, Ltd) contains some interesting and important articles Sir Macfarlane Burnet, for example, examines the riddle of the influenza virus and shows that growing knowledge of the influenza virus leads to the conclusion that, while this has distinct antigenic, enzymic and genetic properties, it is at the same time chemically indistinguishable from fragments of the cytoplasm of the cells in which it is a parasite, this conclusion is of fundamental importance, not only in devising new methods of attacking what can be a very deadly disease but also for understanding the structure and function of the vertebrate cell Dr Charles Singer describes some of Robert Hooke's brilliant contributions to biology, and Dr. E N. Willmer discusses the sensation which human beings call "white". "Storms in the Ionosphere" is the subject of an article by Sir Edward Appleton, while the place of James Muspratt and his family in the British heavy chemical industry is considered by Dr. D. W. F. Hardie. Dr A. Frey-Wyssling describes some information collected by the use of the electron microscope in plant cytology, and Prof. Munro Fox surveys the principal types of coloration in animals and is supported by some colour photographs which have been faultlessly reproduced.

Research in the Social Sciences

THE National Institute of Economic and Social Research has again published its Register of Research in the Social Sciences. This follows the plan of the ten previous numbers, although two substantial changes have been made. The first has been to cut down drastically the amount of repetition of information that has already been recorded in previous issues This will mean that, for fuller information about research items that have already been reported in a previous Register, the user must consult that issue, the reference back is given in each case New information about work in progress or work newly completed has been included The second change has been to revise the section of the classification dealing with economics The new classification replaces one that had become progressively less suitable as a means of classifying contemporary research in Great Britain The year 1953–54 shows a substantial increase in the number of new research projects that have been reported, the total having risen from 201 in 1952–53 to 291 in the current Register This increase is largely the consequence of the impact of the Conditional Aid economic and social research programmes in Great Britain. These new programmes, supported by funds derived from the United States, have provided finance for about sixty of the new inquiries reported here The programmes are designed to encourage and expand research of all kinds into factors affecting the efficiency of the national economy Thus nearly half the economic research recorded here into business structure and functioning, monopoly and competition, productivity and efficiency, is supported by Conditional Aid, it also provides funds for a quarter of the work in industrial relations and management.

City of Manchester Public Libraries: Report for the Year 1953–54

THE hundred and second report of the City of Manchester Public Libraries Committee (pp. 16+28+35+4 plates, Manchester Public Libraries, 1954) covers the year ended March 31, 1954, but records the death of the City Librarian, Mr. Charles Nowell, on August 9, 1954, while the report was in preparation Although the reference libraries continued to attract more readers—627,847 in place of 602,528 the previous year, with an increase in the issue of books from 719,361 to 769,917—fewer books were borrowed from the lending libraries, and the total number of volumes issued to readers decreased from 6,241,375 to 5,929,621. The addition of 102,115 volumes brought the total stock to 1,095,333, of which 663,074 are available for loan A census of users of the central library during 9 a m –9 p m. was made on March 30, 1954, and the results are detailed in a summary accompanying, like the usual statistical summary, the annual report. Of 4,156 entering the library, 3,080 completed the census form as requested of 689 users of the reference library, 237 lived in Manchester and 452 elsewhere, in the commercial library there were 192 Manchester residents to 305 outside the City boundary, in the technical library the proportion was 123 to 170, and in the central lending library, as might be expected, there were 816 Manchester residents to 314 non-residents. Of those visiting the periodicals room, 143 were Manchester residents and 120 from outside the City boundary, for the Henry Watson music library the corresponding figures were seventy-two and eighty-five, respectively, while eight readers visiting the special collections were non-residents of Manchester and three residents. Following the publication of the Manchester Joint Research Council's survey, "Science and Industry", the 225 firms participating in the survey were circularized with a brief statement of the services offered by the technical library, which now holds 86,572 volumes, and a selection of the latest publications A large proportion of the inquiries received were connected with technical research or development The number of readers using the library increased by 4,812 to 150,388, and the number of periodicals consulted increased, although the number of books used decreased slightly Stress is laid on the importance of co-operation in this field and on the cost of scientific and technical books, which during the year averaged 40*s* 8*d* per volume.

Nitrogen Metabolism of Groundnut Plants

L. FOWDEN (*Ann. Bot.*, 18, 72, 417, 1954), in an investigation of the nitrogen metabolism of *Arachis hypogaea*, has considered in some detail the role of γ-methyleneglutamine and γ-methyleneglutamic acid —two new compounds which are apparently not widely distributed in plants, as are, for example, asparagine and glutamine. The evidence that γ-methyleneglutamine was not present in ungerminated groundnut seeds and that γ-methyleneglutamic acid could not be detected in an acid hydrolysate of arachin, the principal reserve protein of groundnut seeds, suggested the possibility that important differences may be encountered between the roles of the new amide in groundnut plants and those of asparagine and glutamine in other species. The changes in various nitrogenous fractions during the growth of groundnut seedlings in the dark were compared with those occurring in seedlings grown in the light. The distribution of amides and acidic amino-acids in the various organs of young and mature plants has also been studied quantitatively, and observations have been made upon the amino-acids present in developing fruits. The author discusses the possible pathways of synthesis and the functions of these two substances in the groundnut plant.

Rayleigh Waves in a Medium with Two Surface Layers

THE problem of the propagation of waves of Rayleigh type in a uniform semi-infinite elastic medium with two uniform surface layers has been solved by R. Stoneley, in a paper entitled "Rayleigh Waves in a Medium with Two Surface Layers" (*Mon Not Roy. Astro. Soc*, Geophys. Supp, 6, No. 9, 610, 1954). The waves are dispersive, and the wave velocity equation turns out to be a determinant of the tenth order Various tests on the equation proved it to be satisfactory for example, by making infinite the thickness of the surface sheet it is possible to derive the velocity equation for waves in an internal stratum, and by making the thickness of either sheet zero, the known equation for the velocity of Rayleigh waves in a medium with a single surface layer is obtained If the wave-length is very small, the determinant reduces to the product of three determinants, which, equated in turn to zero, are the velocity equations of very short Rayleigh waves at the free surface and of very short waves of Rayleigh type at the two interfaces. Dr. Stoneley intends to give the results of a numerical solution of th wave equation at a later date, as well as a discussio of the application of the results to the actual surfa waves of earthquakes.

"The Rationalist Annual"

AMONG the articles contributed to "The Rationali Annual" for 1955 (pp. 81. London C. A. Wat and Co, Ltd, 1954. Cloth, 5*s*., paper, 2*s* 6*d*) a the late Sir Arthur Keith's comparison of Darw and Locke as philosophers, "Darwin's Place amon Philosophers". Sir Arthur claimed that if Locke accepted as a philosopher, Darwin must be regarde as one too, and he added that Darwin was the on philosopher known to him who could help in th interpretation of the problems of nationality an war which vex our modern world. Mrs Margar Knight suggests that good and evil, and joy an pain, are reconciled, in the only sense in which the reconciliation is possible, on the æsthetic plane; bu her essay seems to touch the experience of th scientist, as such, less than those of Prof. Morr Ginsberg on "Durkheim's Theory of Religion" an Prof. J. B. S Haldane on "The Origin of Purpose' Prof. V. Gordon Childe writes briefly on "The Ston Age comes to Life", E. H Hutton on "Religion an the Physicists", Antony Flew on "The Third Maxim' an analysis of the reason J B S. Haldane once gav for not being a materialist, Bertram Joseph on "Th Renaissance Mind" and Ernest Gellner "On Bein Wrong".

Microwave and Radio-frequency Spectroscopy

THE Faraday Society will hold a General Dis cussion on "Microwave and Radio-frequency Spectro scopy" in the Department of Zoology, University o Cambridge, during April 4–6. The programme wil be in four parts, at each of which a general intro duction will be given by the person shown micro wave spectroscopy (Prof H. C Longuet-Higgins University of Cambridge), microwave absorptio (Dr T M Sugden, University of Cambridge) nuclear magnetic resonance (Prof. H. S Gutowsky University of Illinois), and quadrupole spectroscop (Prof B. P. Dailey, Columbia University) Twenty three papers will be read, and advance proofs will b circulated about the middle of March. Application for accommodation must be made by March 23 Further information can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square Gray's Inn, London, W.C 1

Summer School of Welding

THE fifth Summer School of Welding organized by the British Welding Research Association will be held at Ashorne Hill, near Leamington Spa, Warwickshire, during June 27–July 2 The School will take for its basic theme "Welding Developments in British Industry", and has been devised to cover various aspects in logical sequence during the course As in previous years, lectures of general interest will be given in the morning, and lectures of more specialized interest in the afternoon To meet particular requirements, the course will be divided into the following groups *A*, pressure vessels, *B*, transport, *C*, shipbuilding, *D*, specialized welding techniques. It is possible that an additional group on "Inspection and Testing" will also be included Further information can be obtained from the Organizing Secretary, Summer School of Welding, B W.R A, 29 Park Crescent, London, W 1

The Night Sky in March

Full moon occurs on March 8d. 15h 41m, U.T., and new moon on March 24d. 03h 42m. The following conjunctions with the moon take place March 4d. 10h, Jupiter 2° N, March 13d. 22h., Saturn 6° N, March 21d 02h, Venus 4° S, March 22d 11h, Mercury 7° S, March 27d 11h, Mars 3° S, March 31d 16h, Jupiter 2° N. Mercury rises a little before 6h up to the middle of the month, and about 5h 30m at the end of the month—only a quarter of an hour before sunrise—and is unfavourably placed for observation during the whole of March Venus rises about 5h up to the middle of the month, and an hour before sunrise on March 31. It will be conspicuous in the eastern sky and will become more easily observed in the northern hemisphere owing to its increasing northerly declination, the visible portion of its illuminated disk increases from 0·651 to 0·753, and its stellar magnitude varies from −3·7 to −3·5 between March 1 and 31. Mars rises at 22h. 30m during the month, its eastward movement in Aries brings it close to δ Arietis about March 26, and during the month its stellar magnitude varies from 1·4 to 1·7, largely owing to its distance from the earth increasing from 176 to 197 million miles Jupiter, visible throughout the night and early morning hours, sets at 5h, 4h and 3h. on March 1, 15 and 31, respectively, its decrease in brightness from magnitude −2 to −1·8 is due to its distance from the earth increasing from 424 to 464 million miles during the month. Saturn rises at 0h 10m, 23h. 10m and 22h. 05m on March 1, 15 and 31, respectively, and lies rather low in Libra, stellar magnitude 0·6–0·5, the small increase in brightness resulting from its distance from the earth decreasing from 886 to 848 million miles Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich March 1d 22h 02·6m, 99 Tau (*D*), March 2d 23h 59·7m, 1 Gem (*D*), March 10d 21h. 33·5m, 370*B*, Vir (*R*), March 28d 19h 09·6m, 284*B*, Tau (*D*), March 28d. 21h 53·4m, τ Tau (*D*), March 31d 22h 49·7m, *g* Gem (*D*), where *D* and *R* refer to disappearance and reappearance, respectively. Vernal equinox occurs on March 21d 10h

Announcements

Dr H G Taylor, director of research of the British Welding Research Association since 1947, has been elected president of the Society of Engineers.

Dr Gerhard Herzberg, director of the Division of Physics of the National Research Council of Canada, has been elected an Honorary Fellow of the Indian Academy of Sciences "in recognition of his scientific eminence and of his outstanding contributions to knowledge"

The second Marjory Stephenson Memorial Lecture arranged by the Society for General Microbiology will be given by Prof C B Van Niel, of the Hopkins Marine Biological Station, Pacific Grove, California, at the Royal Institution, Albemarle Street, London, on April 18, at 6 p m He will speak on "Natural Selection in the Microbial World" The Lecture is open to the public.

The U S Administration has asked the National Academy of Sciences to appoint a committee to advise on the formulation of Federal Government policy dealing with the relations between questions of loyalty and the awarding of grants and contracts in support of unclassified scientific research

Dr. F W G White, C B.E, chief executive officer of the Commonwealth Scientific and Industrial Research Organization, Australia, has been invited by the Government of Egypt to advise it on the organization of scientific research in Egypt Dr. White will visit Egypt under the ægis of the Unesco Technical Assistance Programme for Egypt

Since the Princess Alice appeal for a million pounds for the University College of the West Indies was made on January 15, more than £400,000 has been offered in the form of donations and covenants (see also *Nature* of February 19, p. 328) The money is to be used for the establishment and endowment of teaching and research scholarships, bursaries, etc., a chapel and for general purposes.

A conference to commemorate the jubilee of the announcement by Albert Einstein in 1905 of the theory of relativity will be held this summer at Berne under the presidency of Prof. W. Pauli (Zurich). Prof. A Mercier (Institute of Theoretical Physics, University of Berne) will act as secretary for the conference Several authorities on cosmology, unified field theories, etc, have been invited to give addresses or take part in the scientific discussions

The Universities Federation for Animal Welfare will hold its Easter congress in St Patrick's Hall, University of Reading, during April 1–4. The fee for the congress, which includes full board and all expeditions, is 3 guineas (students 30*s*) Applications should be addressed to Miss M. P. Williams, UFAW, 7*a* Lamb's Conduit Passage, London, W.C 1, from whom further information can be obtained.

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the academic year beginning on October 1, a limited number of postgraduate scholarships in agricultural economics, husbandry, statistics and agricultural and dairy engineering The closing date for applications is March 31 Further information can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch), 1–4 Cambridge Terrace, Regent's Park, London, N W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

A Sub-Section of the University and Research Section of the Library Association has been formed, the object of which is to foster the formation, growth and usefulness of libraries in colleges of technology and further education The committee consists of the following *Chairman*, L L. Ardern (Manchester College of Technology), *Vice-Chairman*, E G Baxter (Coventry Technical College), *Honorary Secretary*, G. H. Wright (Westminster Technical College), *Honorary Treasurer*, E R. Yescombe (Northern Polytechnic, London), *Members*, F. C Adey (Leicester Colleges of Art and Technology), O M. V. Argles (Hatfield Technical College), J. Fry (Cardiff Technical College) and E. R McColvin (Regent Street Polytechnic, London) Further information can be obtained from the honorary secretary, Gordon H. Wright, Greenway Court, Hollingbourne, Kent

A memorial service for the late Sir Edward Mellanby will be held at the church of St Martin-in-the-Fields, London, at 11 30 a m on March 17

THE NUFFIELD FOUNDATION

ANNUAL REPORT

THE ninth report of the Nuffield Foundation* covers the year ended March 31, 1954, when the Foundation's second five-year programme terminated, in which allocations totalling £594,302 brought the total of grants during the quinquennium to more than £3 million, and that since the Foundation was established in 1943 to more than £5 million Grants in the United Kingdom during the year included £18,938 from the Foundation's uncommitted resources, or 'free fund', £104,450 for biological studies and £120,445 for sociological studies. £189,428 was allocated for research in the Commonwealth overseas, £46,400 for research into practical problems, £51,080 for the care of old people, £46,178 for miscellaneous projects and £27,226 for the continuation of its past programme, while a further £10,000 was allocated to the Oliver Bird Fund

Reviewing first, however, the past quinquennium as a whole, the report notes that of £3,031,526 allocated in 1949–54, £441,897 was for biological and £376,188 for other scientific studies and £416,555 for social research in the United Kingdom £396,080 was for the care of old people and £146,070 for research on rheumatism, while the programme of training and travelling fellowships and similar awards received £515,056 During the quinquennium, while continuing its provision of scholarships designed to encourage travel for study within the Commonwealth, the Foundation has thought it opportune to extend help for research to institutions and people in overseas parts of the Commonwealth, where private-adventure money is more keenly needed, sought and valued. The latest allocation has been one of £250,000 for certain university colleges in the Colonial territories, and the Foundation hopes that on an expanding scale it may devote its attention to overseas parts of the Commonwealth, where growth is still young and vigorous and experiment is necessarily the order of the day.

Another innovation during the quinquennium has been the decision, in the light of an investigation into hospital functions and design, to establish for ten years a division for architectural studies as part of the Foundation's headquarters organization. The immediate programme of the new division includes the study of children's hospitals, research laboratories and farm buildings.

During the coming five years, the Foundation hopes to make its major contribution to the support of research in the United Kingdom in science, medicine and technology. In science its present preference and programme for biology will continue but on a reduced scale, and within the natural sciences the Foundation will be watchful for opportunities of encouraging those workers capable of devising the new concepts tools or techniques from which unpredictable, but invaluable, advances may ensue In medicine, the Foundation intends to build up further two or three existing centres of research on the chronic rheumatic diseases and will maintain a special interest in investigations into the causes of those mental and physical defects which throw so heavy a burden on the family and the community. In technology, besides agriculture, architecture, food and domestic science, the application of science to industry and fundamental applied science, the Foundation is ready to retain an interest in the shortage of scientists and able persons generally, and particularly in the shortage of science teachers in schools.

In the social sciences, the Foundation will be concerned to encourage fundamental research as well as studies of major social developments effected by legislation or similar means, urban studies, further work on social mobility and the problem of local government. Besides encouraging the collection and collation of facts about old people, the Foundation will be ready to assist research in the employment of elderly workers and into the process of ageing. All the current fellowship schemes are being continued, but some will be replaced during the quinquennium by new and experimental schemes.

Both new grants from the Foundation's 'free fund' during the year are in the medical field £6,000 for accommodation for a gastro-enterological research centre at the Central Middlesex Hospital, and £2,500 to the Department of Surgery at the Postgraduate Medical School of London for the construction of a second and improved heart–lung machine. An additional £5,000 has been allocated to the Mathematical Laboratory, University of Cambridge, for the construction of an electronic calculating machine and a further £5,000 reserved for another year.

In the biological sciences, grants were made for twelve new projects and for ten additional or renewed projects. New grants include £12,000 over four years to the Department of Botany, The Queen's University, Belfast, for quaternary ecological studies, £10,000 over five years to the Botanical Society of the British Isles towards the preparation of a distribution atlas of British flowering plants, and £10,000 to the Cavendish Laboratory, University of Cambridge, for the purchase of an electron microscope of high resolving power; £4,300 over two years for work on population genetics at the Department of Social and Preventive Medicine, The Queen's University, Belfast, £3,200 over four years to the Department of Zoology, University of Edinburgh, for special equipment and technical assistance in work on developmental energetics, and £2,500 a year for three years for additional research assistance and materials for the work on vitamin A and the metabolism of sterols in the Department of Biochemistry, University of Liverpool. An additional £1,500 has been contributed to the biophysical work at the Wheatstone Physics Laboratory, King's College, University of London, £2,400 over three years for research at University College, London, on electrical changes in central nervous tissues, a further £7,950 over three years for the investigation at University College, London, into proliferation and morphogenesis in the adult, and a renewed tapering contribution of £2,400 a year for the first three years and £1,200 a year for the last two years for the work on cell biology at the Strangeways Research Laboratory, Cambridge. Further sums of £2,000 a year for equipment and materials and £650 a year for two years for an additional assistant physicist have been offered to the Department of Physics Applied to Medicine, Middlesex Hospital Medical School, for the study of the mineral activity of adrenal steroids.

---

* Nuffield Foundation Report for the year ended 31 March 1954 Pp 141. (London Nuffield Foundation, 1954)

Six of the twelve grants made for sociological studies during the year were new. One of those, of £4,500 over two years, is for an inquiry being conducted by the Institute of Community Studies, London, into various aspects of ageing in relation to family life and care within the family. Another, of £3,000 a year for three years, is to the Institute of Education, University of London, for an inquiry into the social characteristics of the teaching profession, including the changing geographical and social sources of recruitment to the teaching profession in England and Wales, and the relation of its origins to characteristic features of its way of life. A grant of £3,000 over two years has also been made to the Royal Institute of Public Administration for an inquiry into alternative sources of local revenue the results of which should greatly assist in deciding upon the character of the local government reforms required in Britain. Two grants have been made to the Institute of Social Anthropology, University of Oxford: one of £1,000 for a study in Cyprus and the other of £1,500 over three and a half years for a structural analysis of the State of Israel, with special regard to its position as a Middle Eastern nation.

Renewed or additional grants in this field include £3,600 over three years for research of the 'operational' type at the Department of Social Science, University of Liverpool, for the continuation of studies on community and race-relations. A grant of £10,000, tapering from £3,600 in the first year to £400 in the fifth, has been offered to the Division of Research Techniques, London School of Economics and Political Science, for current field-research on methods of reducing the cost of random sampling, the variability between interviewers, the design of questionnaires and social classifications and their use in sampling inquiries. £8,000 goes to the Institute of Statistics, University of Oxford, for a third national survey of income and savings and a further £2,500 over two years to the Department of Psychology, University of Reading, for continuing its work on visual aids to learning. A renewed grant of £2,000 a year for two years to the Department of Town Planning, University College, London, will enable the main results so far reached in case-studies of three local planning authorities to be tested against comparable material from other authorities.

Of two new grants from the Oliver Bird Fund made during the year, one of £20,000 (since increased to £27,000) is to provide and furnish a new building for the Rheumatic Unit at the Northern General Hospital, Edinburgh, while since the end of the financial year covered by the report the Foundation has offered a further £70,000 over eight years to the Rheumatism Research Centre at the University of Manchester, £8,000 to the University of Sheffield for a research fellowship in the Sheffield Centre for the Investigation and Treatment of Rheumatic Diseases and £6,000 to the Oxford Regional Hospital Board for work on the pathogenesis of rheumatic diseases at the Rheumatic Diseases Research Centre, Stoke Mandeville Hospital.

Apart from the grants for new developments in university colleges in the Colonial territories already noted (and which for Ibadan and the West Indies have already led to agreed schemes), the Foundation allocated £19,821 during the year for expenditure, preferably on biological research, in Australia, New Zealand and South Africa, and £20,475 for four projects in other parts of the Commonwealth. The former includes £2,480 over two years to the University of Sydney for fundamental work in the Department of Organic Chemistry on the biogenesis of natural products, using radioactive tracers, £9,760 over three years for a programme of twin studies at the Walter and Eliza Hall Institute of Medical Research, Melbourne, and £750 a year for three years to the University of the Witwatersrand for research on cardiac surgery in general and mitral disease in particular. Up to £2,000 has been offered to the Aden Protectorate for the advancement of a modern health service, and £1,600 over three years to the University College of the West Indies for an inquiry into the Collembola of Jamaican soils.

Four new grants for research into practical problems, totalling £45,200, and which involve bringing together people from two or more disciplines, were made during the year. A grant of up to £6,500 a year for three years to the Social Rehabilitation Unit at the Belmont Hospital, Sutton, is for an intensive study of the social and cultural background of a series of cases of psychopathy treated in the Unit. £15,000 has been allocated over two years for an independent study of the impact of television on children and young people, and the Foundation has offered £700 for equipment and £1,400 a year for five years to University College, London, for a study of skill in heavy manual tasks by the Departments of Physiology and Psychology.

The miscellaneous projects to which the Foundation allocated £46,178 during the year include grants of £1,000 towards the cost of the Third Congress of the International Association of Gerontology, £2,000 for an industrial accidents survey by the Central Middlesex Hospital and £15,000 over five years to establish a day-centre for the permanently disabled under the supervision of Dr F. S. Cooksey, of King's College Hospital. New grants for the care of old people include £3,000 a year for three years to the University of Bristol for field-experiments on the employment of elderly workers, £1,500 a year for five years to the Geriatric Unit, Sunderland General Hospital, for a study of physiological and pathological changes in the aged and ageing and £1,750 a year over three years to Cowley Road Hospital, Oxford, for an investigation in the geriatric unit of the mental deterioration of the elderly.

The Royal Society and Nuffield Foundation Commonwealth bursaries scheme established in 1953–54 is designed to complement the Foundation's other awards, more especially by encouraging able young scientists from Great Britain and overseas to work with leaders of research in other overseas parts of the Commonwealth. The scheme is to run for an experimental period of five years, during which the Foundation will contribute £5,000 a year with an initial contribution of £2,500 from the Royal Society. The medical fellowships are being continued on a reduced scale and the dental fellowships and scholarships, biological and sociological scholarships and bursaries are also being continued. The scheme of travelling fellowships for home Civil servants has been renewed for a second five years, but the travelling scholarships and bursaries for United Kingdom farmers will terminate in April 1956.

Grants in continuation of the past programme include £1,000 a year for three years for the investigation of changes which occur at birth in the circulation and breathing of lambs, £13,200 to the Department of Physics, Birkbeck College, University of London, for two research fellowships for three years for work on protein and virus structure, and £15,000 over five years to the Nuffield Research Group in the Department of Metallurgy at the Imperial College of Science and Technology, University of London, to tide the group over the time until full support is forthcoming from industry and the College for its work on the theory and practice of the extraction of metals from ore.

THE MINING INDUSTRY IN BRITAIN

INTERESTING human documents, though written primarily as the technical record of the work of the Mines Inspectorate in England, are a series of separate reports of the divisional inspectors of five divisions* Though ostensibly all written with the same objective, they have a refreshing variety, and are indications of the widely differing characters of the separate coalfields, which have required from a centrally controlled authority differences of approach appropriate to local conditions and practices

Naturally one's first search among these pages must be for the signs of improvement in the statistics of the killed and injured each year that must inevitably, one would think, take place as the result of the considerable attention that is given to the problem of safety In some divisions one finds an encouraging record of betterment, in others there are to be found an almost discouraging fluctuation of figures from one year to another that must have some deep-seated causes. On reading the separate reports, it very soon becomes apparent that the character of the pits varies widely—thin seams and thick seams, high standards of mechanization, less-developed ones, and wide differences in the character of the mining problems Perhaps the common problem is the stubbornness of human nature, shown in the repeated instances of accidents due to individual carelessness that has resulted in neglect of regulations framed for their prevention The major sources of fatal accidents are falls of roof and haulage breakdowns, particularly runaways

Interesting to the layman in these reports are the many references to the development of new methods and appliances culled from a wide field of experiment carried out both in and outside the industry of coal mining—thus the colorimetric testing of coal dust, the new developments of electric haulage, the ever-advancing character of the new devices for dealing with roof support, the vital problem of the miner, and the many new types of machine for coal cutting The introduction of machine mining has brought in its train new problems in dust suppression Following the experience which many mining engineers have had of the effect of water on the mining of coal, there is growing up a body of opinion which believes in this development, which must reduce the use of coal-cutters and shot firing and thus reduce the production of dust. In this application a long hole parallel to the coal-face is drilled, filled with explosive, and then high-pressure water admitted, the objective being to soften the coal

In spite of all the research and care taken in mine air analysis and other precautions, explosions of fire damp still occur—a pertinent reminder that in no branch of mining technology can it be said that all the problems have yet been solved.

On the surface and underground, good progress has been made in the improvement of the standards of illumination The removal of glare and shadows is an important feature of such advancement

Health and welfare, training and education occupy an essential place in the manifold activities of the mining industry Finally, it is interesting to note that the first electrically driven, horse-cleaning vacuum equipment operated by a certified flame-proof motor and switchgear was installed at the beginning of the year in the underground stables, 3,000 yards from the pit bottom at Hamstead Colliery. Should it be called an equus-cleaner? R J SARJANT

OVERSEAS FOOD CORPORATION

ANNUAL REPORT

THE Overseas Food Corporation is now concerned solely with investigations, first to ascertain experimentally crop and stock potentialities, with their cultural and husbandry requirements, second, to determine their practical limitations and economics, by applying the findings of the specialists to large-scale trials by farmers, and third, by incorporating in the large-scale trials variations in farming methods, to ascertain which form is likely to prove most productive and yield the greatest return as and when the area is developed The annual report and statement of accounts for the year ended March 31, 1954*, record steady progress under the first heading. The continued soil surveys, soil fertility studies and the fertilizer experiments are revealing the percentages of the various soil types to be found in the areas, their suitability to the range of crops under trial, their mechanical condition and their response to fertilizer treatment Considerable progress has been made in the study of rosette disease of groundnuts, and that on the mechanism of resistance of Mwitunde to rosette disease indicates reasonable hopes of selecting a strain combining high yield, low aphid reproduction, low percentage of infective aphids and perhaps some tolerance to the usually severe effect of the virus on yield Indications are that groundnuts may become an important crop in the rotation at Nachingwea and merit further trial at Urambo in the 1955–56 season

The second type of investigations was severely checked by the drought throughout Tanganyika during the 1952–53 crop season, but much information was obtained on methods of cultivation desirable under dry-farming conditions Variations in the third class included experiments with farms of 2,000 acres, 1,500 acres and 1,000 acres, fully mechanized and under European supervision, to determine the pattern of farming best suited to local conditions and the most economical size, while the possibilities of improving peasant farming on a group basis are being examined under the African Tenant Scheme

---

* Ministry of Fuel and Power Reports of H M Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953 North Eastern Division By C W Scott Pp ii+30 2*s* net West Midland and Southern Division By J E Henshaw Pp ii+24 1*s* 6*d* net Northern Division By W Brown Pp ii+30 1*s* 6*d* net North Western Division By G Hoyle Pp ii+26+5 plates 2*s* net East Midland Division By W B Brown Pp ii+20 1*s* net (London H M Stationery Office, 1954)

* Overseas Food Corporation Annual Report and Statement of Accounts for the year ended 31st March, 1954 Pp. iv+70 (London H M Stationery Office, 1954) 2*s* 6*d* net

The Equatorie of the Planetis

EDITED BY

D. J PRICE

This book reproduces, translates and describes a fourteenth-century manuscript in the library of Peterhouse which Dr Price believes to be the work of Geoffrey Chaucer and in his hand Whether or not this ascription is accepted—Dr Price sets out the arguments for and against—the *Equatorie* is a valuable Middle English scientific text that is here presented in its proper historical setting. Mr R M Wilson provides a linguistic analysis and a glossary 52*s*. 6*d net*

The Ancient Inhabitants of Jebel Moya

R MUKHERJEE, C. R RAO & J. C TREVOR

This third monograph in the series of Occasional Publications of the Cambridge University Museum of Archaeology and Ethnology deals with the human remains (of the first millennium B C) from the late Sir Henry Wellcome's excavations at Jebel Moya in the Sudan between 1911 and 1914 Apart from the particular data obtained it is important as a guide to method in physical anthropology 40*s*. *net*

CAMBRIDGE UNIVERSITY PRESS

THE WORLD'S GREATEST BOOKSHOP

FOYLES
FOR BOOKS

FAMED CENTRE FOR SCIENTIFIC BOOKS

All new Books available on day of publication. Secondhand and rare Books on every subject. Stock of over three million volumes.

Subscriptions taken for British, American and Continental magazines; and we have a first-class Postal Library.

Foyles have depts. for Gramophone Records, Music, Stationery, Handicraft Tools and Materials.

We BUY Books, Coins, Stamps

119-125 CHARING CROSS ROAD
LONDON WC2

Gerrard 5660 (16 *lines*) ★ *Open* 9–6 (*inc. Sats*)

Two minutes from Tottenham Court Road Station

E. & F. N. SPON

THE YIELDS OF A CROP

Based on an Analysis of Cotton Growing in Egypt

W LAWRENCE BALLS

C M G., C B E , F R S , SC D.(CANTAB), D SC

52 illustrations 21s net

"*An absorbing, coherent and well-documented account of far-reaching interest and importance*" SCIENCE PROGRESS

THE GRASS CROP

Its Development, Use and Maintenance

(*2nd impression*)

WILLIAM DAVIES, D SC

9 illustrations 24 tables 26s. net

"*Particularly valuable and opportune It deserves to be widely read*" AGRICULTURE

22 Henrietta Street, London, W.C.2

MAN in a COLD ENVIRONMENT **30s. net**

By Alan C. Burton, Ph.D., *and* O. G. Edholm, M.B.

An evaluation of the physical and physiological problems of man in the cold.

Just published. 248 *pages.* 75 *illustrations.*

ANIMAL LIFE in DESERTS **21s. net**

A study of fauna in relation to the environment.

New edition. 192 *pages.* 43 *illustrations.*

and

THE LOUSE **10s. 6d. net**

An account of the lice which infest men, their medical importance and control.

172 *pages, with* 47 *diagrams.*

By P. A. Buxton, C.M.G., F.R.S.

RIVER PURIFICATION **5s. net**

By F. T. K. Pentelow

A legal and scientific review of the last 100 years.

RIVER POLLUTION **7s. 6d. net**

By H. D. Turing

HYDROGRAPHY in RELATION to FISHERIES **7s. 6d. net**

By John B. Tait, D.Sc., Ph.D.

106 *pages.* 18 *illustrations.*

THE PLAICE **7s. 6d. net**

By R. S. Wimpenny

"We doubt if there is anything of importance left out of this . . . amazing study which originated in the 3 lectures delivered by the writer as Buckland Professor for 1949."—*Fishing Gazette.*

142 *pages.* 27 *illustrations.*

Methods of QUANTITATIVE MICRO-ANALYSIS **70s. net**

By R. F. Milton *and* W. A. Waters

Second edition. 754 *pages.* 201 *illustrations.*

EDWARD ARNOLD

NEW ZEALAND

SCIENCE REVIEW

(11 *issues per annum*)

covers scientific activities in New Zealand

reports original research; book reviews

NEW ZEALAND SCIENCE ABSTRACTS

25s. per annum

DIRECTORY OF

NEW ZEALAND SCIENCE

(*Third Edition*)

lists individual scientists; learned societies

institutions and Government laboratories

New Zealand scientific publications

secondary school teachers, trade section.

- 20s.

OFFICIAL PUBLICATIONS OF

NEW ZEALAND ASSOCIATIONS OF SCIENTISTS

Address enquiries to

The Hon. Editor, P.O. Box 1874, Wellington, C.1,
New Zealand

* * * *

For details of advertising space in both publications apply

London Office:

47 Gresham Street, London, E.C.2. MONarch 7644

AN INTRODUCTION TO THE

BIOLOGY OF YEASTS

By M. INGRAM, M.A., Ph.D

This book describes what the yeasts are and what they do. It begins with an introductory chapter describing the general nature of yeasts, and then deals with the simpler and the more complex metabolic processes. A section is devoted to the process of growth and reproduction, and the book closes with an account of the behaviour of the yeast colony and its place in nature. Illustrated with line drawings and photomicrographs. 25/- net

PITMAN

Parker Street . Kingsway . London, W.C.2.

MACMILLAN BOOKS

Science and its Background

H. D. ANTHONY, M.A.(Cantab.), B.Sc., Ph.D.(Lond.), F.R.A.S.

Here is the story of science, with the background of history in which that story is set. Although most of the chapters centre around individual men of science whose work is of value to-day, the historical background is not only that of isolated biography but the continuous history of human affairs Two chapters, on post-war developments and the pursuit of science for its own sake, have been added for this second edition. *Second Edition* 20*s.*

A Text-book of Electricity and Magnetism

G. R. NOAKES, M.A., F.Inst.P.

This is the new, Third Edition of a book which will meet the need of those taking Intermediate degree courses and the Advanced and Scholarship Examinations of the General Certificate of Education. All the usual topics required at this stage are dealt with, and where necessary calculus is used. Among the special topics discussed are the conduction of electricity through gases, atomic physics and modern views on ferro- and terrestrial magnetism. *Third Edition.* 14*s.*

Advanced Level Examples in Physics

R. V. JOHNS, M.A., B.Sc.

Lecturer in Physics and Mathematics, City of Liverpool College of Technology

W. F. WARE, B.Sc., A.Inst.P.

Senior Physics Master, Cathays High School for Boys, Cardiff

This book of numerical examples is designed to supplement the theoretical and laboratory work of students preparing for examinations in Physics at the Advanced level of the General Certificate of Education and for Intermediate Degree examinations. Some 1,000 examples have been arranged by topics and carefully graded in difficulty. Contents are arranged under the headings Mechanics and Properties of Matter, Heat, Light, Sound, and Magnetism and Electricity. 16*s.*

Semimicro Qualitative Analysis

A Course in Applied Chemical Equilibrium

EDWIN O. WIIG, Ph.D., WILLARD R. LINE, Ph.D., and JOHN F. FLAGG, Ph.D.

This revision of *Semimicro Qualitative Analysis,* while retaining the experimental procedures and much of the form of the earlier text, has been almost completely rewritten. The theoretical section has been considerably expanded, and a large number of problems of varying difficulty (with the answers to many of them) have been added. The sections on special procedures for ferro- and high-aluminium alloys have been modified on the basis of student experience. *Second Edition* 25*s.*

All prices are net

St. Martin's Street, London, W.C.2

I. R. MAXWELL & CO. LTD.

(FORMERLY LANGE, MAXWELL & SPRINGER LTD.)
INTERNATIONAL UNIVERSITY BOOKSELLERS—SUBSCRIPTION AGENTS
DEALERS IN OUT-OF-PRINT PUBLICATIONS

242, MARYLEBONE ROAD LONDON, N.W.

The International Library Suppliers

WITH THE ACTIVE SUPPORT of the world's leading Publishing Houses and the use of modern business methods and the latest office machinery, we have been able to establish, from many years' experience, a supply service for Libraries which is second to none.

Our Library Division offers the following facilities :

- Speedy, reliable and efficient service. Books and periodicals from every country at official rates of exchange.
- Large stocks of out-of-print books, sets and runs of periodicals.
- Regular News Service on new publications, free of charge.
- Extracts, photostats, or microfilms from out-of-print books or journals at low costs.
- Speedy service in hand-binding from our own bindery.
- Translations of foreign language articles.
- Purchase or exchange of surplus books and journals.

BY PLACING YOUR ORDERS WITH US you will be receiving all the advantages which a centralised Library Supply system can offer.

Hutchinson's

RAILWAY MOTIVE POWER

Harry Webster, B.Sc., M.I.Loco.E.

with a foreword by Lt -Col Harold Rudgard, O B E, formerly Chief Officer, Motive Power, British Railways

A survey of the past, present and future, of special interest in view of the recently announced plans for the improvement of our railways 30*s*

THE GYROSCOPE APPLIED

K. I. T. Richardson, M.A.

The modern gyroscope in theory and practice including marine, aeronautical and other applications 30*s*

GENERAL PRINCIPLES OF GEOLOGY

J. F. Kirkaldy, D.Sc., F.G.S.

The latest theoretical knowledge and practical and economic applications of geology described by the Head of the Geology Department, Queen Mary College, London 25*s*.

WORKED EXAMPLES IN THE THEORY OF MACHINES

R. McVie, B.Sc.

The latest addition to the very successful worked example series 12*s* 6*d*

Other titles are **Physics, Chemistry, Electrotechnology** and **Electrical Engineering.** (25s)

All the above books are fully illustrated

FULL CATALOGUE AVAILABLE
ON REQUEST

Scientific & Technical Publications

PERGAMON PRESS

242 MARYLEBONE ROAD
LONDON, N W 1

Forthcoming Books

An Introduction to

Electronic Analogue Computers

By C A A Wass, R A E, Farnborough

(The sixth monograph in the series Electronics and Waves, edited by D W Fry, Harwell)

This is the first British book to give a detailed account of the design operation and applications of analogue computers for electronic differential analyzers Clearly written and completely up to date, it indicates the theory and some of the practice of using analogue computers in practical problems, but emphasizes the equipment and its theory It will be of great importance to designers and users of such equipment, and to students and research workers seeking an introduction for general treatment

Demy 8*vo* *About* 270 *pages* *Well illustrated* 40*s*

Distributed in the Western Hemisphere by the McGraw-Hill Book Co.

Linear Feedback Analysis

By J G Thomason, A E R E, Harwell

This book will bridge the gap between the mathematical treatises on the subject and the works on the practical side of electronics technique A wealth of practical detail accompanies the analytical discussions, a great many illustrative designs taken from radar and nuclear physics research equipment are included, and the standard of mathematics required of the reader is that of an ordinary degree in science or engineering The book is comprehensive and up to date and will be of interest to the specialized circuit and servomechanism research worker, as well as to medical and biological workers with an interest in electronics technique, engineers working in nuclear instrumentation, etc

Demy 8*vo* 355 *pages* 235 *illustrations* 55*s*

Distributed in the Western Hemisphere by the McGraw-Hill Book Co

Progress in Biophysics and Biophysical Chemistry

Volume 5

Edited by J A V Butler and J T Randall, London

Contents Reaction Patterns of a Coliform Organism (A C R Dean and C N Hinshelwood), The Physical Chemistry of Haemolysis and Bacteriolysis by Surface Active Agents and Antibiotics (J H Schulman, B A Pethica, A V Few and M R J Salton), The Direct Action of Ionizing Radiation on Enzymes and Antigens (E C Pollard, W R Guild, F Hutchinson and R B Setlow), Structure and Function of the Chloroplast (J B Thomas), The Theory of X-ray Fibre Diagrams (A R Stokes), Recent Studies on the Reversible Denaturation of Proteins (M Joly)

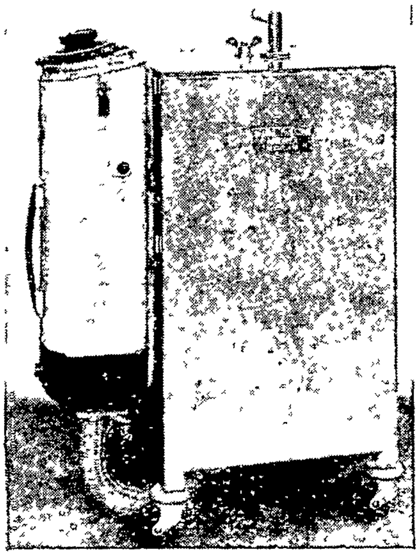
Royal 8*vo* 258 *pages* 70 *illustrations* 55*s*

GRUBB PARSONS

SPECTROMETER AIR DRIER

1 Unit is designed for easy connection to any Grubb Parsons Spectromete Adaptation to other instruments is usually straightforward.
2 Flexible connections 1 in internal diameter are employed.
3 Charge of activated alumina is 80 lb. and life is at least 200 hours 1 cu ft per minute.
4 Unit can be moved about easily.
5 Drier can be supplied with or without Air Blower.
6 Blower is run at reduced voltage and is quite silent
7 A tapped transformer can be supplied as an alternative to the Variac wit some saving in cost
8 An internal heater is provided for trouble-free reactivation with eas measurement of alumina temperature
9 Provision is made for including soda asbestos for elimination of CO_2, required.
10 Drying can be extremely good under favourable conditions—down t 0 01 mg water per cubic foot
11 Unit can also be used for partial room drying by operating blower a full speed.
12 The Drier can be employed for any purpose for which extremely dr air is required.

WRITE FOR FURTHER INFORMATION
DETAILS OF THE COMPLETE RANGE OF INFRA RED SPECTROMETER AND INFRA RED GAS ANALYSERS CAN BE OBTAINED FROM—



Drier complete with detachable Air Blower and Variac speed regulator

SIR HOWARD GRUBB, PARSONS & COMPANY
WALKERGATE, NEWCASTLE UPON TYNE, 6
PROPRIETORS C A PARSONS & COMPANY LIMITED

Manufacturers of optical elements for laboratories and instrument makers

* * *

M. Bender (Northern) Ltd.

Optical Works—
5-21, High Friar Street,
Newcastle upon Tyne, 1
Tel 2-4005/6

SCIENTIFIC BOOKS, LIBRARIES & COLLECTORS

By John L Thornton and R. I. J Tully

A bibliographical approach to the history of science, recording the major writings and definitive editions of all the important scientists, from the earliest times to the end of the nineteenth century.

288 *pages*, 12 *plates* 24*s* (18*s to Library Association Members*)

THE LIBRARY ASSOCIATION
CHAUCER HOUSE, MALET PLACE, LONDON, W.C 1

LEARNED
JOURNALS
BOUGHT

STECHERT-HAFNER INC.
The World's Leading International Booksellers

New York · Paris : Stuttgart
London: Star Yard, Carey Street, W.C.2

THE LIPIDS

Their Chemistry and Biochemistry

by HARRY J DEUEL, Jr
University of Southern California, Los Angeles

In Three Volumes

VOLUME I: CHEMISTRY

CONTENTS General Characteristics and Classification of Lipids The Chemistry of Fatty Acids and Glycerol The Chemistry of Neutral Fats Waxes, Higher Alcohols Including Sterols, Triterpenes, Glyceryl Ethers, Colored Fats, and Hydrocarbons Chemistry of the Phosphatides and Cerebrosides Carotenoids and Related Compounds Distribution, Properties, and Chemistry of the Vitamins A. Distribution, Properties, and Chemistry of the Provitamins D and Vitamins D Distribution, Properties, and Chemistry of the Vitamin E Group. Distribution, Properties and Chemistry of the Vitamin K Group Author and Subject Index Index to Plant and Animal Sources of Lipids

1951 6 × 9 1008 pages, 102 illus, 341 formulas, 204 tables 168s

VOLUME II: BIOCHEMISTRY

Digestion, Absorption, Transport, Transport and Storage

CONTENTS Preface Introduction Digestion and Absorption of Fats in the Gastrointestinal Tract The Digestibility of Fats The Digestion, Absorption, and Digestibility of Lipids Other than Fats Blood Lipids The Occurrence of Lipids in the Animal as a Whole Lipid Distribution in Specific Tissues and in their Secretions Author Index Plant and Animal Sources of Lipids Subject Index.

1955 6 × 9 945 pages, 131 tables 200s

VOLUME III—In preparation.

INTERSCIENCE PUBLISHERS LTD.
88-90 CHANCERY LANE, LONDON, W.C.2

'he SCIENTIFIC BOOK SUPPLY SERVICE
(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE: CEN 1294

FETTER LANE, FLEET STREET, LONDON, E.C.4

WHELDON & WESLEY, LTD.

Specialists for 100 years in

BIOLOGICAL & GEOLOGICAL BOOKS

Catalogues on Request

●

83/84 BERWICK STREET • LONDON • W.1

Books Bought

HEFFER'S

for

Books on the Sciences
and the Humanities
English, American and
European
New and Secondhand

*

W. HEFFER & SONS LIMITED
Petty Cury *Cambridge*

RECENT SCIENTIFIC and TECHNICAL BOOKS

Volumes marked with an asterisk (*) have been received at "Nature" Office

Mathematics

LAMOUCHE, André Le Principe de Simplicité dans les Mathématiques et dans les Sciences Physiques Royal 8vo Pp 482 (Paris Gauthier-Villars et Cie , 1954) 1800 francs *

LAWDEN, Derek F Mathematics of Engineering Systems (Linear and Non-Linear) Demy 8vo Pp viii+380 (London Methuen and Co , Ltd , New York John Wiley and Sons, Inc , 1954) 30*s* net *

LEVI, Howard Elements of Algebra Ex Cr 8vo Pp 160 (New York Chelsea Publishing Company, 1954) 3 25 dollars *

OSTROWSKI, A Vorlesungen uber Differential- und Integralrechnung Dritter Band Integralrechnung auf dem Gebiete mehrerer Variablen (Lehbrucher und Monographien aus dem Gebiete der Exakten Wissenschaften Mathematische Reihe—Band 7) Super Royal 8vo Pp 475 (Basel/Stuttgart Verlag Birkhäuser, 1954) 78 Swiss francs *

TAYLOR, E G R The Mathematical Practitioners of Tudor and Stuart England Demy 8vo Pp xi+443+12 plates (Cambridge At the University Press, 1954 Published for the Institute of Navigation) 55*s* net *

UNITED STATES DEPARTMENT OF COMMERCE National Bureau of Standards Table of Sine and Cosine Integrals for Arguments from 10 to 100 (National Bureau of Standards Applied Mathematics Series—No 32) La Post 4to Pp xv+187 (Washington, D C Government Printing Office, 1954) 2 25 dollars *

WEBER, Ernst Linear Transient Analysis Volume I Lumped-Parameter Two-Terminal Networks Med 8vo Pp xiv+348 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1954) 60*s* net *

Physics

BORN, Max, and HUANG, Kun Dynamical Theory of Crystal Lattices (The International Series of Monographs on Physics) Royal 8vo Pp xii+420 (Oxford Clarendon Press , London Oxford University Press, 1954) 50*s* net *

CASE, K M , HOFFMANN, F de, and PLACZEK, G Introduction to the Theory of Neutron Diffusion (Numerical Work by B Carlson and M Goldstein) Cr 4to Pp viii+174 (Washington, D C Government Printing Office, 1954 Published for the Atomic Energy Commission) 1 25 dollars *

JOHNSTON, J E (edited by), FAIRES, R A , and MILLETT, R J (with the assistance of) Radioisotope Conference 1954, sponsored by the Atomic Energy Research Establishment, Harwell Proceedings of the Second Conference, Oxford, 19–23 July Vol I Medical and Physiological Applications Pp xi+418 65*s* Vol 2 Physical Sciences and Industrial Applications Pp ix+223 45*s* Royal 8vo Set of the two volumes 100*s* (London Butterworths Scientific Publications, 1954)*

LIVINGSTON, M Stanley High-Energy Accelerators (Interscience Tracts on Physics and Astronomy) La Post 8vo Pp viii+157 (New York Interscience Publishers, Inc , London Interscience Publishers, Ltd , 1954) 3 25 dollars *

SWAINGER, Keith Analysis of Deformation Vol 2 Experiment and Applied Theory Demy 8vo Pp. xxxvi+365 (London Chapman and Hall, Ltd , 1954) 70*s* net *

Engineering

DAUGHERTY, R L , and INGERSOLL, A C Fluid Mechanics With Engineering Applications Fifth edition Med 8vo Pp xiii+472 (London McGraw-Hill Publishing Company, Ltd , 1954) 50*s* *

DICKINSON, H W Water Supply of Greater London (Being a series of articles originally published in *The Engineer* in 1948, and now revised and issued as a Memorial Volume and a Tribute to the Author by the Newcomen Society) Cr 4to Pp xvi+151+20 plates (London Newcomen Society, c/o Science Museum, S W 7, 1954) 35*s* *

EVANS, Walter R Control-System Dynamics (McGraw-Hill Electrical and Electronic Engineering Series) Med 8vo Pp xiv+282 (London McGraw-Hill Publishing Company, Ltd , 1954) 50*s* *

KING, Horace Williams Handbook of Hydraulics for the Solution of Hydraulic Problems Fourth edition, revised by Prof Ernest F Brater (McGraw-Hill Handbooks) Cr 8vo Pp xvii+562+vii (London McGraw-Hill Publishing Company, Ltd , 1954) 57*s* 6*d* *

McNEIL, Ian Hydraulic Operation and Control of Machines Demy 8vo Pp xi+324+16 plates (London Thames and Hudson, 1954) 35*s* net *

PARSONS S A J Production Tooling Equipment The Design of Jigs, Tools and Gauges Demy 8vo Pp 336 (London Cleaver-Hume Press, Ltd , 1954) 25*s* net

RIDEOUT, Vincent C Active Networks (Electrical Engineering Series) Demy 8vo Pp xvi+485 (London Constable and Company, Ltd , 1954) 42*s* net *

TEMPLETON, H Mass-Balancing of Aircraft Control Surfaces (A Series of Aeronautical Monographs—Volume 4 Published under the authority of the Royal Aeronautical Society) Demy 8vo Pp. x+241 (London Chapman and Hall, Ltd , 1954) 35*s*. net *

Chemistry · Chemical Industry

BERRY, A J From Classical to Modern Chemistry Some Historical Sketches Demy 8vo Pp xii+251 (Cambridge At the University Press, 1954) 25*s* net *

BOCKRIS, J O'M (edited by), CONWAY, B E (with the assistance of) Modern Aspects of Electrochemistry (Modern Aspects Series of Chemistry—No 1) Demy 8vo Pp x+344 (London Butterworths Scientific Publications , New York Academic Press, Inc , 1954) 40*s* net *

DELAHAY, Paul New Instrumental Methods in Electrochemistry Theory, Instrumentation, and Applications to Analytical and Physical Chemistry With a Chapter on High-Frequency Methods by Charles N Reilley Med. 8vo Pp xvii+437 (New York Interscience Publishers, Inc , London Interscience Publishers, Ltd , 1954) 11 50 dollars *

EPHRAIM, Fritz Inorganic Chemistry Sixth English edition edited by Dr P C L Thorne and Dr E R Roberts Royal 8vo Pp xii+956 (Edinburgh and London Oliver and Boyd, Ltd , 1954) 35*s* net *

HOPKINS, D W Physical Chemistry and Metal Extraction Demy 8vo Pp xv+232 (London J Garnet Miller, Ltd , 1954) 30*s* net *

JIRGENSONS, B , and STRAUMANIS, M E A Short Textbook of Colloid Chemistry Demy 8vo Pp xvi+420 (London Pergamon Press, Ltd , 1954) 40*s* net *

MITCHELL, Jr , John, KOLTHOFF, I M , PROSKAUER, E S , and WEISSBERGER, A (edited by) Organic Analysis Volume 2 Med 8vo Pp viii+372 (New York Interscience Publishers, Inc , London Interscience Publishers, Ltd , 1954) 8 50 dollars *

MIZUSHIMA, S Structure of Molecules and Internal Rotation (Physical Chemistry—a Series of Monographs) Med 8vo Pp x+244 (New York Academic Press, Inc , London Academic Books, Ltd , 1954) 6 dollars*

PARTINGTON, J R An Advanced Treatise on Physical Chemistry Vol 5 Molecular Spectra and Structure, Dielectrics and Dipole Moments Royal 8vo Pp x+565 (London Longmans, Green and Co , Ltd., 1954) 80*s* net *

PETERS, Max S Elementary Chemical Engineering (McGraw-Hill Series in Chemical Engineering) Med 8vo Pp ix+322 (London McGraw-Hill Publishing Company, 1954) 46*s* 6*d* *

STEACIE, E W R Atomic and Free Radical Reactions (American Chemical Society Monograph Series—No 125) Volume I Pp x+486 Volume 2 Pp iii+487–901. Second edition Med 8vo (New York Reinhold Publishing Corporation , London Chapman and Hall, Ltd , 1954) 224*s* net the two volumes *

WIIG, Edwin O , LINE, Willard R , and FLAGG, John F Semimicro Qualitative Analysis a Course in Applied Chemical Equilibrium Med 8vo Pp viii+238 (New York D Van Nostrand Company, Inc , London Macmillan and Co , Ltd , 1954) 25*s* net *

Technology

PLASTICS ENGINEERING HANDBOOK of the Society of the Plastics Industry, Inc Med 8vo Pp xxxv+813 (New York Reinhold Publishing Corporation , London Chapman and Hall, Ltd , 1954) 120*s* net *

PROCEEDINGS of the Third International Symposium on the Chemistry of Cement, London 1952 (Held under the auspices of the Building Research Station of the Department of Scientific and Industrial Research and the Cement and Concrete Association) Royal 8vo. Pp xxxviii+870 (London Cement and Concrete Association, 1954) 60*s* *

SINGER, Charles, HOLMYARD, E J , and HALL, A R (edited by) JAFFÉ, E , THOMSON, R H G , and DONALDSON, J M (assisted by) A History of Technology Volume I From Early Times to Fall of Ancient Empires Cr 4to Pp lv+8 maps+828+36 plates (Oxford Claren don Press , London Oxford University Press, 1954) £7 7*s* net *

SONNEBORN, Ralph H , with contributions by DIETZ, Albert G H , and HEYSER, Alton S Fiberglas Reinforced Plastics Demy 8vo Pp xii+240 (New York Reinhold Publishing Corporation , London Chapman and Hall, Ltd , 1954) 36*s* net *

Astronomy

ANNUAIRE pour l'An 1955, publié par le Bureau des Longitudes, avec un Supplement pour l'An 1956 Cr 8vo Pp viii+550+101 (Paris Gauthier-Villars, 1955) 850 francs *

DE VAUCOULEURS, Gerard Physics of the Planet Mars An Introduction to Aerophysics Demy 8vo Pp 365+9 plates (London Faber and Faber, Limited, 1954) 50*s* net *

LOVELL, A C B Meteor Astronomy (International Series of Monographs on Physics) Royal 8vo Pp xiv+463+3 plates (Oxford Clarendon Press , London Oxford University Press, 1954) 60*s* net *

PAYNE-GAPOSCHKIN, Cecilia Variable Stars and Galactic Structure Royal 8vo Pp xii+116 (London Athlone Press (University of London), 1954 Distributed by Constable and Co , Ltd) 18*s* net *

Geology Mineralogy

Directory of British Fossiliferous Localities Demy 8vo Pp xiv+268 (London Palaeontographical Society, 1954) 7*s* 6*d* *

HARKER, Alfred Petrology for Students an Introduction to the Study of Rocks Under the Microscope Eighth edition, revised (Cambridge Geological Series) Cr 8vo Pp viii+283 (Cambridge At the University Press, 1954) 18*s* net *

PARKER, Robert L Die Mineralfunde der Schweizer Alpen (Revidierte und erganzte Neuauflage von Band I, Teil II aus "Die Mineralien der Schweizeralpen," von P Niggli, J Koenigsberger und R L Parker) Super Royal 8vo Pp vii+311+34 plates (Basel Wepf and Co Verlag, 1954) 36 Swiss francs *

Geography · Travel

ADDISON, William Thames Estuary Med 8vo Pp xii+211 (London Robert Hale, Ltd , 1954) 18*s*

DEANE, Shirley Rocks and Olives Portrait of an Italian Village Large Post 8vo. Pp vii+179 (London John Murray (Publishers), Ltd , 1954) 12*s* 6*d*

KINROSS, Lord Within the Taurus a Journey in Asiatic Turkey Med 8vo Pp xi+191 (London JohnMurray (Publishers), Ltd , 1954) 18*s*

SITWELL, Sacheverell Portugal and Madeira Med 8vo Pp 242 (London B T Batsford, Ltd , 1954) 18*s*

General Biology : Natural History Botany : Zoology

CLIFTON, Charles E (edited by) RAFFEL, Sidney, and STANIER, Roger Y (in association with) Annual Review of Microbiology Volume 8, 1954 Med 8vo Pp viii+536 (Stanford, Calif Annual Reviews, Inc , 1954) 7 dollars *

COLE, William H (edited by) Serological Approaches to Studies of Protein Structure and Metabolism (Rutgers University Bureau of Biological Research—Annual Conferences on Protein Metabolism) Med 8vo Pp xi+97 (New Brunswick, N J Rutgers University Press, 1954) 2 dollars *

de BEER, Sir Gavin Archaeopteryx Lithographica a Study based upon the British Museum Specimen Royal 4to Pp xi+68+16 plates (London British Museum (Natural History), 1954) 40*s* *

DELACOUR, Jean The Water Fowl of the World Volume I The Magpie Goose, Whistling Ducks, Swans and Geese, Sheldgeese and Shelducks Cr 4to Pp 284+16 plates (London *Country Life*, Ltd , 1954) 105*s* *

de LATIL, Pierre The Underwater Naturalist (Translated from the French by Edward Fitzgerald) Demy 8vo Pp 275+15 plates (London Jarrolds Publishers (London), Ltd , 1954) 16*s* net *

ENGLER, A Syllabus der Pflanzenfamilien mit besonderer Berucksichtigung der Nutzpflanzen nebst einer Übersicht uber die Florenreiche und Florengebiete der Erde Zwolfte, vollig neugestaltete auflage von Prof Hans Melchior und Prof Erich Werdermann Band I Bakterien bis Gymnospermen Super Royal 8vo Pp viii+368 (Berlin-Nikolassee Gebrüder Borntraeger, 1954) n p *

INSTITUT DES PARCS NATIONAUX DU CONGO BELGE Exploration du Parc National de la Garamba Mission H de Saeger en collaboration avec P Baert, G Demoulin, I Denisoff, J Martin, M Micha, A Noirfalise, P Schoemaker, G Troupin et J Verschuren Fascicule I Introduction Par Henri de Saeger Imperial 8vo Pp 107+61 plates (Bruxelles l'Institut des Parcs Nationaux du Congo Belge, 1954) n p *

JACOBSEN, Hermann Handbuch der sukkulenten Pflanzen Beschreibung und Kultur der Sukkulenten mit Ausnahme der Cactaceae Band I Abromeitielle bis Euphorbia Super Roy 8vo Pp xv+614 (Jena Veb Gustav Fischer Verlag, 1954) 58 D marks *

KLENSCH, Herbert Einfuhrung in die Biologische Registriertechnik Super Royal 8vo Pp xii+222 (Stuttgart Georg Thieme Verlag, 1954) 33 D marks *

LANCUM, F Howard Badgers' Year Cr 8vo Pp vii+71 (London Crosby Lockwood and Son, Ltd , 1954) 6*s* 6*d* net *

LOCKLEY, R M The Seals and the Curragh Introducing the Natural History of the Grey Seal of the North Atlantic Demy 8vo Pp vii+149+8 plates (London J M Dent and Sons, Ltd , 1954) 15*s* net *

MARSHALL, A J Bower-Birds Their Displays and Breeding Cycles—a Preliminary Statement Royal 8vo Pp ii+416+27 plates (Oxford Clarendon Press , London Oxford University Press, 1954) 30*s* net *

SHORTEN, Monica Squirrels (New Naturalist Special Volume) Large Post 8vo Pp xii+212+15 plates (London William Collins, Sons and Co , Ltd , 1954) 15*s* net *

SWINTON, W E Fossil Amphibians and Reptiles Demy 8vo Pp xiii+114+17 plates (London British Museum (Natural History), 1954) 5*s* *

Agriculture Horticulture · Forestry

NORMAN, A G (edited by) Advances in Agronomy (Prepared under the auspices of the American Society of Agronomy) Volume 6 Med 8vo Pp ix+383 (New York Academic Press, Inc , London Academic Books, Ltd , 1954) 8 dollars *

SEARLE, Sidney A (edited by) Plant Climate and Irrigation Demy 8vo Pp xi+155 (Chichester Chichester Press, Ltd , 1954) 20*s* *

SYNGE, P M , and LANNING, R (edited by) The Fruit Year Book, 1955 No 8 Med 8vo Pp 142 (London Royal Horticultural Society, 1954) 10*s*

WILLIS, Stephen J Weed Control in Farm and Garden (Agricultural and Horticultural Students Series) Cr 8vo Pp 184+6 plates (London Vinton and Company, Ltd , 1954) 8*s* 6*d* net *

Biochemistry Physiology

BRADLEY, Stanley E Renal Function Transactions of the Fifth Conference, October 14, 15 and 16, 1953, Princeton, N J Med 8vo Pp 218 (New York Josiah Macy, Jr , Foundation, 1954) 3 75 dollars *

DELAFRESNAYE, J F (edited by) Brain Mechanisms and Consciousness (A Symposium organized by the Council for International Organizations of Medical Sciences, established under the joint auspices of UNESCO and WHO) Demy 8vo Pp xv+556 (27 plates) (Oxford Blackwell Scientific Publications, 1954) 42*s* net *

GLASCOCK, R F Isotopic Gas Analysis for Biochemists Med 8vo Pp viii+247 (New York Academic Press, Inc , London Academic Books, Ltd , 1954) 5 80 dollars *

KLYNE, W (edited by) Progress in Stereochemistry (Progress Series) Vol I Royal 8vo Pp x+378 (London Butterworths Scientific Publications , New York Academic Press, Inc , 1954) 50*s* net *

MRAK, E M , and STEWART, G F (edited by) Advances in Food Research Vol 5 Med 8vo Pp x+538 (New York Academic Press, Inc , London Academic Books, Ltd , 1954) 11 50 dollars *

Anthropology Archæology

PENDLEBURY, J D S A Handbook to the Palace of Minos at Knossos, with Its Dependencies Demy 8vo Pp 76+14 plates (London Max Parrish and Co , Ltd , 1954) 12*s* 6*d* net *

SPENCER, Robert F (edited by) Method and Perspective in Anthropology Papers in honor of Wilson D Wallis Demy 8vo Pp xii+323 (Minneapolis University of Minnesota Press , London Oxford University Press, 1954) 36*s* net *

WHEELER, Sir Mortimer Rome Beyond the Imperial Frontiers Demy 8vo Pp xii+192+38 plates (London G Bell and Sons, Ltd , 1954) 25*s* net *

Philosophy Psychology

CORNFORTH, Maurice Dialectical Materialism An Introductory Course Volume 3 The Theory of Knowledge Cr 8vo Pp 240 (London Lawrence and Wishart, Ltd , 1954) 10*s* 6*d* net *

CREEL, H G Chinese Thought from Confucius to Mao Tse-tung Med 8vo Pp 301 (London Eyre and Spottiswoode (Publishers), Ltd , 1954) 21*s*

DINGLE, Herbert The Sources of Eddington's Philosophy (Eighth Arthur Stanley Eddington Memorial Lecture, 2 November, 1954) Small Cr 8vo Pp vi+64 (Cambridge ' At the University Press, 1954) 3*s* 6*d* net *

DOOLAN, A Philosophy for the Layman Demy 8vo Pp xi+246 (Dublin Dominican Publications, 1954) 12*s* 6*d*

GUILFORD, J P Psychometric Methods (McGraw-Hill Series in Psychology) Second edition Med 8vo Pp ix+597 (London McGraw-Hill Publishing Company, Ltd , 1954) 61*s* *

HUNE, H A K The Humanism of Cicero Med 8vo Pp viii+221 (Melbourne Melbourne University Press , London Cambridge University Press, 1954) 30*s*

JUNG, C G The Development of Personality Edited and Translated by F R C Hull (Collected Works of C G Jung—17) Royal 8vo Pp viii+325 (London Routledge and Kegan Paul, Ltd , 1954) 25*s* net

LUCE, A A Sense Without Matter or Direct Perception Demy 8vo Pp ix+166 (Edinburgh and London Thomas Nelson and Sons, Ltd , 1954) 12*s* 6*d* net *

SLUCKIN, W Minds and Machines (Pelican Book A808) Small Cr 8vo Pp 223 (Harmondsworth, Mddx Penguin Books, Ltd , 1954) 2*s* *

WORDSWORTH, J C Pain and Other Problems a Criticism of Modern Philosophies La Post 8vo Pp 160 (London George Allen and Unwin, Ltd , 1954) 12*s* 6*d* net *

Miscellany

B B C HANDBOOK, 1955 Cr 8vo Pp 224 (London British Broadcasting Corporation, 1954) 5*s* *

GALDSTON, Iago The Meaning of Social Medicine Ex Cr 8vo. Pp xii+137 (Cambridge, Mass Harvard University Press , London Oxford University Press, 1954 Published for the Commonwealth Fund) 22*s* net *

GREGORY, C C L , and KOHSEN, Anita Physical and Psychical Research An Analysis of Belief Demy 8vo Pp ix+213 (Reigate Omega Press, 1954) 15*s* net *

HARRIS, I Man's Place in the Universe the Third Testament La Post 8vo Pp xii+87 (London C A Watts and Co , Ltd , 1954) 7*s* 6*d*. net *

HASLETT, A W (edited by) Science News, No 34 Small Cr 8vo Pp 128+16 plates (Harmondsworth, Mddx Penguin Books, Ltd , 1954) 2*s* *

HESSE, Mary B Science and the Human Imagination Aspects of the History and Logic of Physical Science Demy 8vo Pp 171 (London Student Christian Movement Press, Ltd , 1954) 12*s* 6*d* net *

LANG, Ruth (compiled and edited by) Laboratory and Workshop Notes 1950–1952 a Third Selection reprinted from the *Journal of Scientific Instruments* Demy 8vo Pp xii+280 (London Edward Arnold (Publishers), Ltd , 1954) 30*s* net *

LAPIERE, Richard T A Theory of Social Control (McGraw-Hill Series in Sociology and Anthropology) Med 8vo Pp xi+568 (London McGraw-Hill Publishing Company, Ltd , 1954) 53*s* 6*d* *

MACGREGOR-MORRIS, J T The Inventor of the Valve a Biography of Sir Ambrose Fleming Demy 8vo Pp 134 (London Television Society, 1954) 10*s* *

MORGENSTERN, Oskar (edited by) Economic Activity Analysis Med 8vo Pp xviii+554 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1954) 54*s* net *

PIGGOTT, Mary (edited, with an introduction by) Cataloguing Principles and Practice an Enquiry (Lectures delivered at a Vacation Course of the University of London School of Librarianship and Archives, in March 1953) Demy 8vo Pp viii+159 (London Library Association, 1954) 14*s* *

POTTER, Grace E , and STEINHOFF, William R (edited by) Papers of the Michigan Academy of Science, Arts and Letters Volume 39 1953 Meeting Pp ix+496+iii (Ann Arbor University of Michigan Press , London Oxford University Press, 1954) 80*s* net *

RHINE, J B The Reach of the Mind (Pelican Book A319) Small Cr. 8vo Pp 198+8 plates (Harmondsworth, Mddx Penguin Books, Ltd , 1954) 2*s*, 6*d* *

STEVENSON, George S (edited by) Administrative Medicine Transactions of the Second Conference, December 8, 9 and 10, 1953, Princeton, N J Med 8vo Pp 164 (New York Josiah Macy, Jr Foundation, 1954) 3 dollars *

TAYLOR, F Sherwood. Power To-day and To-morrow The Application of Energy to Human Needs Large Post 8vo Pp 192+12 plates (London Frederick Muller, Ltd , 1954) 15*s* net *

THORNTON, John L , and TULLY, R I J Scientific Books, Libraries and Collectors a Study of Bibliography and the Book Trade in Relation to Science Demy 8vo Pp x+288+12 plates (London Library Association, 1954) 24*s* *

von BAHR, G , ten DOESSCHATE, J , BUNAU, H Fisher-Von, FRANCOIS, J , GOLDMANN, H , LO CASCIO, G , MÜLLER, H K , NORDMANN, Jean, SCHAEFFER, A J , and SORSBY, Ardold (edited by) Documenta Ophthalmologica Advances in Ophthalmology Volume 7/8 Royal 8vo Pp 758+28 plates ('S-Gravenhage Dr W Junk, 1954) 125 guilders *

WAKSMAN, Selman A My Life with the Microbes Med 8vo Pp xii+364 (New York Simon and Schuster, Inc , 1954) 5 dollars *

WEIL, B H (edited by) The Technical Report Its Preparation, Processing, and Use in Industry and Government Med 8vo Pp xii+485 (New York Reinhold Publishing Corporation , London Chapman and Hall, Ltd , 1954) 96*s* net *

high vacua

APIEZON products — always keeping pace with improved techniques developed in the last twenty years — include oils, waxes, greases and sealing compounds designed to produce and maintain the highest vacua now practicable.

Write for the comprehensive booklet which describes their uses in detail

even to 10^{-8} mm Hg

Shell Chemicals Limited
(DISTRIBUTORS)
Norman House, 105-109 Strand, W C 2 *Tel* TEM 4455

Divisional Offices

Walter House, Bedford St, London, W C 2 *Tel* TEM 4455
42 Deansgate, Manchester *Tel* Deansgate 6451
39 Corporation St, Birmingham 2 *Tel* Midland 6954
28 St Enoch Square, Glasgow, C 1 *Tel* Glasgow Central 9561
53 Middle Abbey St, Dublin *Tel* Dublin 45775
35-37 Boyne Square, Belfast *Tel* Belfast 20081

"APIEZON" is a Registered Trade Mark of Apiezon Products Ltd

with APIEZON products

LEAD FOR RADIATION SCREENING

We have long experience of lead working and can supply any type of lead screen shield or collimating device either solid cast or fabricated and welded to your own design

We supply lead containers for storing and transporting radioactive isotopes. We also manufacture lead bricks for screening castles, etc, and lead items for any experimental purposes

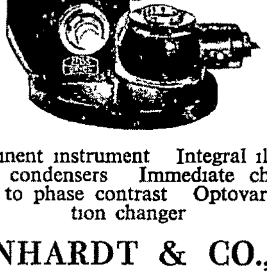
P. E. RANDALL LTD.
25–26, FLOODGATE ST, BIRMINGHAM 5
Phone MIDland 5533

Secondhand Microscopes
BOUGHT FOR CASH OR TAKEN IN EXCHANGE
CLARKSON'S 338 High Holborn, W.C.1
Opposite Gray's Inn Road. 'Phone HOLborn 2149

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE
FROM LIVER OR YEAST
and other SIGMA brand products are now available.
Ask for list SIGMA 8
GEORGE T. GURR LTD.
136-138 NEW KINGS RD, LONDON, S W.6
The Microscopical Stain People

CARL ZEISS

W MODEL MICROSCOPE



The pre-eminent instrument Integral illumination Pre-centred condensers Immediate change from bright field to phase contrast Optovar magnification changer

DEGENHARDT & CO., LTD.
32 MADDOX STREET, LONDON, W 1
Mayfair 6639
Sole Importers for Gt Britain and N Ireland

WANTED TO PURCHASE

Scientific books & periodicals

Entire libraries, and smaller collections;
sets and runs, foreign and domestic.

WALTER J. JOHNSON, INC.
125 East 23 Street, New York, 10, N.Y., U.S.A.
Cable Address BOOKJOHNS, NEW YORK
British Office: ACADEMIC BOOKS, LTD.
129 Queensway, London, W.2

Scientific Circulations Ltd.

We have extensive stocks of Technical Journals, Periodicals and Textbooks. Special terms for Technical and Commercial Libraries. All Scientific and Technical publications purchased.

111, Eastbourne Mews, London, W.2
Telephone AMBassador 6934

THE MUSEUM BOOK STORE, LTD.
25 Devonshire St., London, W.1
(Welbeck 1340)

Buy and sell Scientific Journals and Periodicals and Learned Society Publications, in all languages. Librarians, and others, should send us their list of "wants", or duplicates for sale. *Binding undertaken*

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to all Leading Universities, Public Libraries and Institutions of the World. Catalogues issued

★

SELLING?

Specialists in Scientific, Technical Books and Publications of all Learned Societies.

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephone: Wel. 7948, Amb. 5991

The Faraday Society

THE BOURKE LECTURES

A LECTURESHIP, to be known as the Bourke Lectureship, has been established by the Society to enable distinguished scientists from overseas to lecture in London, Oxford, Cambridge and provincial university centres for the purpose of promoting the study of Physical Chemistry and allied subjects. It is proposed to hold these lectures once or twice a year.

Professor D. F. HORNIG, Ph.D.

(*Professor of Chemistry, Brown University, Rhode Island*)

has been invited to give the first Bourke Lectures

ON

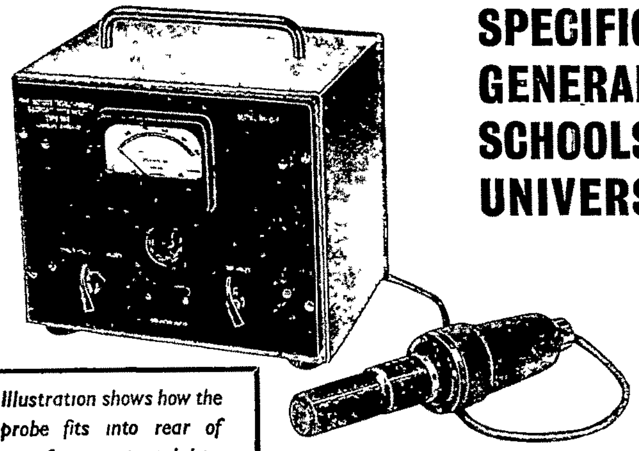
"**Spectra and Structure of Crystals,**" to be held in the Department of Chemistry, King's College, London, W.C.2, on Wednesday, March 2, 1955, at 5.30 p.m. (Chairman: Professor Sir Eric Rideal, M.B.E., D.Sc., F.R.S.)

"**Bond Moments and Molecular Structure,**" to be held in the Department of Chemistry, The University of Manchester, on Tuesday, March 15, 1955, at 4 p.m. (Chairman: Professor Geoffrey Gee, Sc.D., F.R.S.)

"**Application of Shock Waves to Chemical Problems,**" to be held in the Department of Physical Chemistry, The University, Cambridge, on Tuesday, May 3, 1955, at 4.30 p.m. (Chairman Professor R. G. W. Norrish, Sc.D., F.R.I.C., F.R.S.)

Admission free, without ticket. Non-Members will be welcome

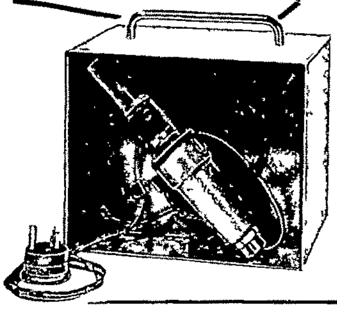
THE FARADAY SOCIETY,
6 Gray's Inn Square, London, W.C.1



SPECIFICALLY DESIGNED FOR GENERAL EDUCATION IN SCHOOLS, COLLEGES AND UNIVERSITIES

THE 'I D L' RADIOACTIVITY METER is robust and simple to use and capable of making a wide range of measurements on beta and gamma rays Also suitable as an inexpensive general purpose laboratory monitor

Illustration shows how the probe fits into rear of unit for easy portability.



- ***Trigger "flash" for low count rates and checking purposes.***
- ***Weston Meter Indication 0-50 counts/second.***
- ***Adjustable E.H.T. 300-600 volts indicated on meter, for plateau measurements.***
- ***Self-contained with probe and G.M. tube for beta and gamma counting.***

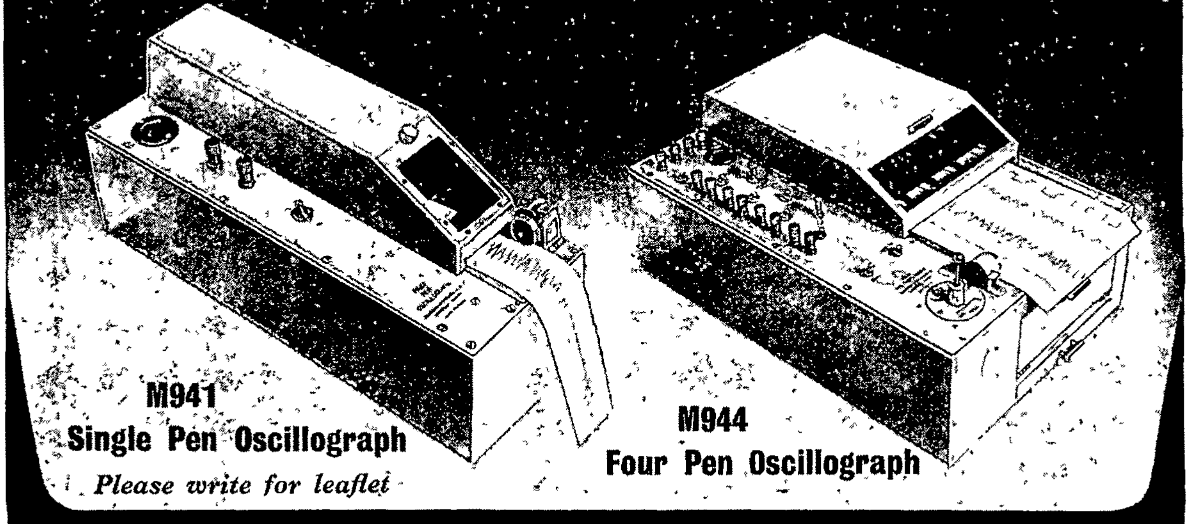
Full particulars from

ISOTOPE DEVELOPMENTS LTD.

Laboratory and Works
BEENHAM GRANGE, ALDERMASTON WHARF
Nr READING, BERKS

London Sales Office
120 MOORGATE, LONDON, E.C 2
Telephone METropolitan 9641 (5 lines)

MINIRACK PEN OSCILLOGRAPHS

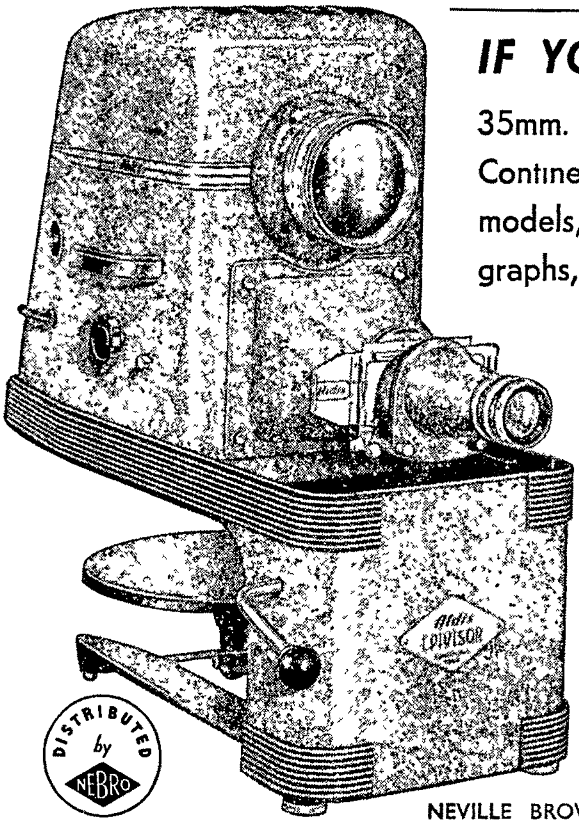


M941
Single Pen Oscillograph
Please write for leaflet

M944
Four Pen Oscillograph

SOUTHERN INSTRUMENTS LIMITED
CAMBERLEY SURREY

Telephone: Camberley 2230 (3 lines) Telegraphic Address: "Minrak, Camberley, England"



IF YOU WANT TO PROJECT

35mm. film strips, 2"x2" or $3\frac{1}{4}$"x$3\frac{1}{4}$" slides, Continental slides, micro slides, specimens, models, drawings, blueprints, photographs, graphs, etc., etc. . . .

THERE IS ONLY ONE ANSWER

Aldis 'EPIVISOR'

(Registered Trade Mark)

EPIDIASCOPE

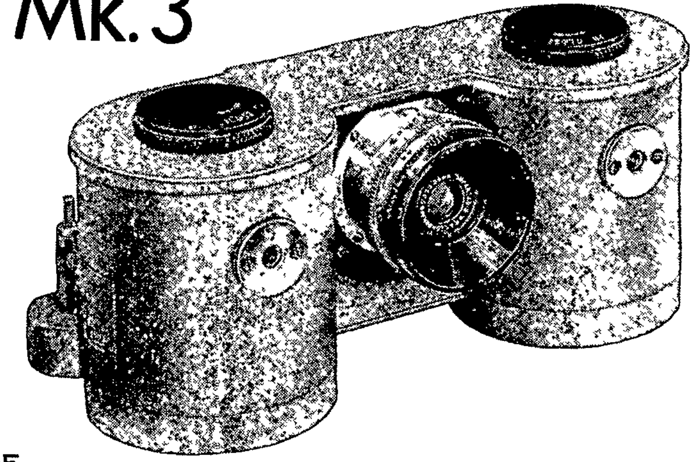
This versatile instrument enables you to project greatly enlarged and perfectly defined images of flat and solid objects, as well as film strips and slides. It is indispensable in research and in training Full details will gladly be sent on request, together with the name of your nearest dealer, who will be pleased to demonstrate.

DISTRIBUTED by NEBRO

Sole Wholesale Distributors.
NEVILLE BROWN & CO LTD, 77 NEWMAN ST, LONDON, W.1

The Auto Camera Mk.3

A VERSATILE RECORDING INSTRUMENT



Specially designed to cover a wide field of industrial and scientific work where the rapid production of high quality microfilms is required It is eminently suitable for such purposes as instrument recording, photomicrography, oscillograph records, process timing, document copying, etc. It is fully automatic in its operation, the exposure and film transport being effected by a single electrical impulse operating on 12 or 24 volt d c. Special daylight loading cassettes give a full 200 1" × 1" or 300 1" × $\frac{3}{4}$" exposures from one loading of 35 mm perforated film. The camera may also be controlled by manual operation

Write for 16-page illustrated brochure.

THE INSTRUMENT DIVISION OF

D. Shackman and Sons CHILTERN WORKS CHESHAM · BUCKS

Watson Stereoscopic Microscopes will satisfy the most fastidious user.

They are available in a wide range of stands and can be fitted with a variety of optics Offering, as they do, a true stereoscopic image, they can be applied to any problem where the three dimensions, length, breadth and depth, are to be investigated The illustration is of the "Box-Foot" model Write for List 6B

WATSON'S

W. WATSON & SONS LTD. 313 HIGH HOLBORN, LONDON, W.C.1

THERMOSTATIC WATER BATHS MADE BY GRANT INSTRUMENTS

(1) Cover the range from 10° to 90° C, with a differential of ± 0.25° C. The whole range is clearly marked out on the dial, in single degrees, and the required temperature can be precisely set.

(2) Are fitted with an accurate bimetallic thermostat, of new design, which works on the micro-switch principle without a relay and without arcing at the contacts.

(3) Have extremely efficient stirring, by induction motor, which ensures that there is no measurable temperature gradient throughout the bath.

(4) Have 1500 or 3000 watt heaters which give very rapid heating

(5) Can now be fitted with fan cooling to the control box, recommended for continuous operation over 40° C., to prevent overheating and condensation.

(6) Are protected by a strong wooden casing, with air gap, giving good heat insulation.

(7) Are unconditionally guaranteed for 12 months, and covered by a 48 hour repair service.

Type UB2 is a heavy steel pressing, vitreous enamelled. The non-drip lid is of aluminium. All SB types are of stainless steel with stainless steel non-drip lids

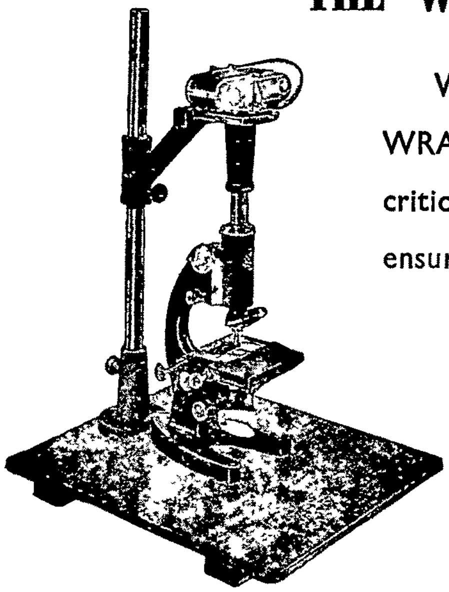
Standard Types	*UB2*	*SB1*	*SB2*	*SB3*
Working Space	18"×8¼"×6¼"	10"×8¼"×7"	17"×8¼"×8"	21½"×12"×11½"
Shipping Weight	56 lb.	48 lb	56 lb.	100 lb.
Export packing	£2 10 0	£2 10 0	£2 10 0	£3 0 0
PRICE	**£22 10 0**	**£25 5 0**	**£26 10 0**	**£29 0 0**

Lids, non-drip. UB2, 39/-, SB1, 49/-, SB2, 60/-, SB3, 95/- Constant Level Device, Cooling System (all baths), 30/- each. Fan Cooling (all baths), 40/-. Standard Test Tube racks for all tube sizes available in stainless steel or aluminium.

We shall be glad to send any further information required, but have tried to set out above, as clearly as possible, the most important information which an intending user might need to know.

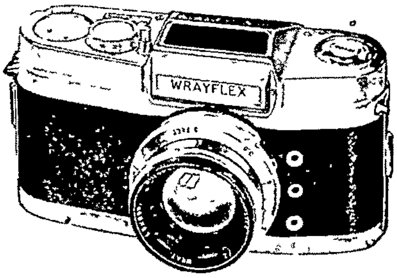
GRANT INSTRUMENTS, 8-9 PETTY CURY, CAMBRIDGE. *Telephone* 3580

THE WRAYFLEX & PHOTOMICROGRAPHY



With the aid of a specially designed adapter the WRAYFLEX can be coupled to any microscope for highly critical photomicrographs. The eye-level reflex focusing ensures a pin-sharp image at any degree of magnification.

For Copying and Macrography, the WRAYFLEX camera with its range of interchangeable lenses and extension rings allowing for visual focusing through the taking lens at any distance is becoming increasingly popular among scientific workers.

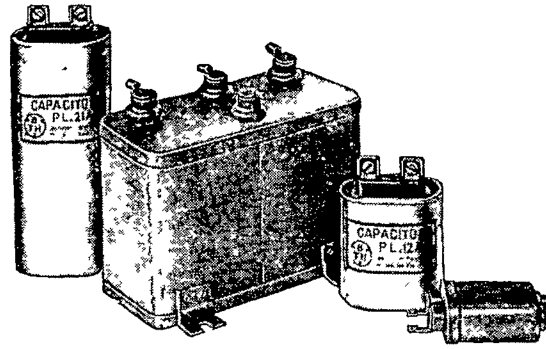


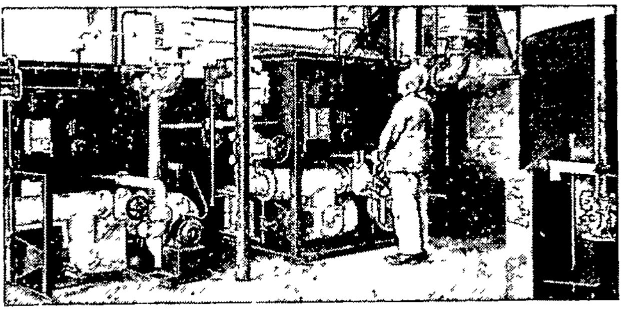
The WRAYFLEX fitted with the 5 cm f/2 Unilite lens

WRAY (OPTICAL WORKS) LTD., BROMLEY, KENT

DRY AIR FOR IMPROVED VACUUM WORK

Thorough insulation impregnation by alternate vacuum and pressure cycles demands the rigid exclusion of moisture from the system by BIRLEC LECTRODRYERS BIRLEC LECTRODRYERS are applicable to a number of electrical applications including the dry blanketing of transformers during assembly, the dry storage of delicate components and insulating material and the drying of gases for lamp filling, electrode annealing etc





A selection of capacitors for fluorescent lighting equipment and ignition units which are vacuum impregnated faster and better by the installation of a Birlec Lectrodryer (Right) Two special Lectrodryers designed for working in conjunction with an insulating impregnation tank
Both photographs are published by kind permission of the British Thomson-Houston Co Ltd

Please send me details of LECTRODRYERS for electrical work

Application

Name

Company

IVW

DRYER DIVISION OF
BIRLEC LTD

ERDINGTON
BIRMINGHAM 24

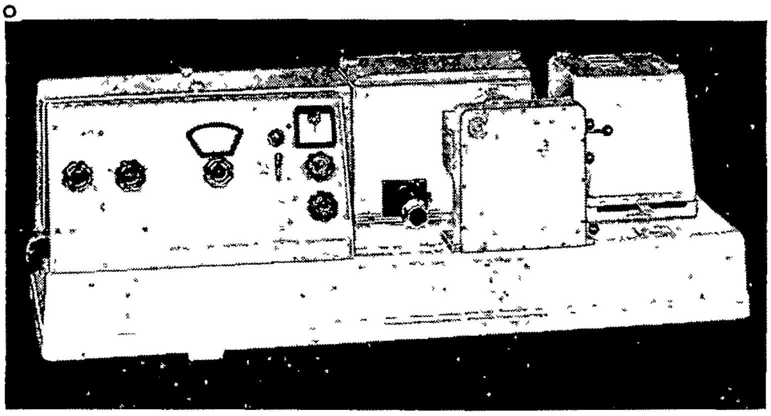
Member of the AEI Group of Companies.

sm/B 2131 54

NEW UVISPEK

photoelectric spectrophotometer

THE NEW UVISPEK is an outstandingly sensitive and accurate photoelectric spectrophotometer for use in the ultra-violet and visible regions, with a very wide field of applications in the research and industrial laboratory. Its outstanding features are :



REDESIGN OF MEASURING UNIT gives even greater ease of servicing and operation.

MEASUREMENTS OVER THE FULL U-V AND VISIBLE RANGE from 200 to 1,000 mμ can be made with quartz prism.

DISPERSION, NEARLY FOUR TIMES AS GREAT, in the visible region with optional glass prism.

NO BATTERIES are used ; simply connect to A.C. mains.

EXCEPTIONALLY HIGH SENSITIVITY which can be reduced when it is too great for the measurement in hand.

PROVISION FOR FLAME ATTACHMENT without removing lamp-house.

QUICK DELIVERY ; REASONABLE PRICE.

Please write for fully illustrated catalogue CH318 (N.2)

HILGER & WATTS LTD. HILGER DIVISION
98 St. Pancras Way, London, N.W.1, England

Member of the Scientific Instrument Manufacturers' Association and of SCIEX

The Corporation maintains close touch with the East African Agricultural and Forestry Research Organization and with the East African Tsetse and Trypanosomiasis Research and Reclamation Organization, as well as with departments of the Tanganyika Government and other bodies; but the work of the Scientific Department is presented on a regional basis in what forms the longest chapter of the report. Among some points of interest are the slight increase in plant population and the big increase in yield obtained in experiments on the control of weeds in maize with 'Fernoxone' at Urambo; the absence of any significant increase in yield of soya bean and maize on deep placement of triple phosphate fertilizer although the standard method of placing fertilizer gave highly significant increase; the identification in South Tanganyika of the maize rust *Puccinia polysora* Underw.; and the continued trials and experiments on the development and improvement of agricultural machinery. Soil fertility studies were restricted to maize, and little progress is reported in the determination of the phosphate status of soils by chemical tests.

METEORIC PARTICLES IN THE ATMOSPHERE

ZDENĚK ŠVESTKA, Astronomical Institute of the Czechoslovak Academy of Sciences, Ondřejov, has a paper in *Bulletin of the Astronomical Institutes of Czechoslovakia* (5, No. 5, Sept. 1, 1954), in which he criticizes F. Link's theory of the fall and absorption influence of meteoritic particles in the atmosphere. This theory has been explained in some of the *B.A.C.* issues over several years, and the time of fall T in seconds through 100 km may be expressed by Link's approximate formula

$$\log_{10} T = C - 1{\cdot}5 \log_{10} \rho$$

where $C = 1.4$ for metallic particles and 1.6 for stony particles, the radius of the particles in all cases being ρ. According to this formula, the time of fall of 30–100 days would correspond to particles the diameters of which in the limit would conform with the relation $4\mu < 2\rho < 14\mu$. From a study of the absorption influence of particles of different diameters Link also constructed an empirical formula for the number n of particles of iron and silicates of different sizes

$$\log_{10} n = \text{constant} - 600\,\rho$$

and making use of other data, concluded that the absorption in a layer of meteoric dust is caused predominantly by particles with diameters from 2μ to 6μ.

Švestka has now examined Link's assumptions and deductions and concludes that the latter are inaccurate in many cases. Observations of absorption effects of a dust-layer in the atmosphere during lunar eclipses can be satisfied only when the optical thickness of the layer is equal to 0.01 as a minimum. A table gives for different values of ρ the minimum possible time of fall for which the above optical thickness is assumed, and also the maximum quantity of meteoric matter falling on the earth, which, it is shown, cannot exceed 5×10^{-14} gm. cm.$^{-2}$ sec.$^{-1}$, and proves that it is quite impossible—from the optical point of view—that the observed absorption could be caused by particles larger than 1μ. Link's theoretical conclusions were based on Thomsen's results of collections of atmospheric iron particles, the diameters of which ranged from 10μ to 80μ; but there is very strong evidence from the collection of similar particles in the industrial country of Jena that the meteoritic nature of Thomsen's particles must be open to considerable doubt. It seems probable that meteoric dust is formed by much smaller particles of the order of 10^{-5}–10^{-6} cm., and it is suggested that a study of the sky-light polarization, during and after the activity of strong meteor showers, might provide a decisive answer to the problem under investigation.

THE EARTH'S EXTERIOR ATMOSPHERE AND THE COUNTERGLOW

UNDER this title, the Canadian Defence Research Board has published a second augmented edition of material prepared by E. R. Hope*. In the main this consists of Mr. Hope's translations of recent Russian papers (two more than the first edition) of very great interest concerning observations and theories about the outermost atmosphere of the earth.

The Russian astronomers, Astapovich, Fesenkov, Divari and Karimov, have a particular claim to our attention, for they enjoy in some parts of their country a clarity of the sky which is unrivalled and which is a great asset to the observations concerning the outermost atmosphere and the counterglow. Their revolutionary theories are based in part on new observational discoveries, and their speculations make good use of all the knowledge there is on the subject. They establish that the observational material is in accord with the suggestion that a gaseous tail stretches away from the earth, resembling the tail of a comet, in the direction opposite to that of the sun. They do not suggest that the processes responsible for the heating of the outermost atmosphere or for the acceleration of the gas spraying off in the tail are at all understood.

The translator's foreword of twenty-six pages aims at reviewing the entire subject in a critical manner, and at establishing the relation between these outer atmosphere researches and those connected with magnetic and auroral effects. Much of this could come under severe criticism, and one suspects that most of the authors mentioned would disagree with the arguments presented that oppose their points of view, but equally with those that are in their favour. Those who are concerned with these subjects will have to go over the literature and the arguments for themselves, anyway; and those who would appreciate a passing acquaintance cannot be advised to gain it here, for they are unlikely to appreciate that another review article might, with equal justification, reverse very many of the arguments.

The translations of the Russian papers read well, and make a valuable contribution to the literature accessible to most Western astronomers and to those concerned with upper atmosphere research.

T. GOLD

---

* The Earth's Exterior Atmosphere and the Counterglow. The Counterglow as Related to Modern Geophysical Theories, with Seven Recent Russian papers. Collected and translated by E. R. Hope. Second edition. (T 65 R.) Pp. xxviii+52. (Ottawa: Defence Research Board (Defence Scientific Information Service), 1954.)

MOBILITY OF MANGANESE, MAGNESIUM AND POTASSIUM IN LEAF TISSUES

By H. C RUCK and Prof. F G. GREGORY, F.R S

Research Institute of Plant Physiology, Imperial College of Science and Technology, London, S.W 7

BY the use of rooted leaf cuttings, the mobility of metallic elements from fully active leaves can be studied in a simple way Leaves with axillary buds were detached from potato plants grown in sand culture supplied with nutrient solutions so that the level of the element in the leaves could be controlled. The isolated leaves were set to root in sand or appropriate culture solution, and after fourteen days root formation began, and in most cases the axillary bud grew out into a shoot. At the time of planting out, one leaflet of a pair was removed and analysed The axillary shoot developed deficiency symptoms when the cutting was grown in solutions deficient in the element under investigation When the symptoms had become marked, the opposite leaflet of the pair was removed and analysed The accuracy of the method for determining movement of the element from the leaf depends on the high correlation between mineral content of the paired leaflets. The following mean values were obtained for the distal pair of leaflets in μgm.

Mn (12 leaflets)	2·56	2·46
Mg (10 leaflets)	116	106
K (10 leaflets)	420	360

Manganese

Leaf-bud cuttings with high and relatively low manganese content were used and after rooting transferred to a culture solution without manganese

Typical symptoms of manganese-deficiency appeared in the shoot after twenty-three days in the low-manganese leaves, and after thirty days in the high-manganese set. The subtending leaf meanwhile remained normally green and without any symptoms. The analyses of the leaflets for manganese (p p m in dry weight) at the beginning and after forty days were as follows

		At planting out	After 40 days	
High Mn cuttings	grown in Mn deficient solution	150	148	Mean of 8 replicates
Low Mn cuttings		25	20	Mean of 13 replicates

The appearance of the high-manganese cuttings at the end of the experiment is shown in Fig 1, *A* The axillary shoot shows severe deficiency, while the subtending leaf remains healthy In neither series has the concentration of manganese in the subtending leaf fallen to any marked degree, indicating that manganese is not transported from the active leaf to the growing bud

Magnesium

A similar experiment was carried out using plants grown in a full nutrient solution The cuttings, after rooting, were grown on either in a solution containing magnesium or completely magnesium-free Symptoms of magnesium-deficiency appeared in the set grown without magnesium after thirty-seven days in the form of grey spots and scorch on the lower leaves of the shoot After forty-nine days the experiment ended

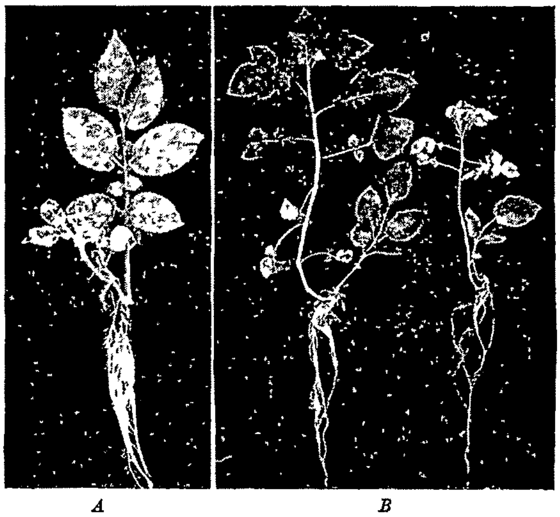


Fig 1 *A*, Leaf-bud cutting from a potato plant grown at high-manganese level, and after rooting transferred to a manganese-free solution *B*, leaf-bud cuttings taken from a plant grown at high-magnesium level and after rooting transferred to a solution with magnesium (left) or devoid of magnesium (right)

The content of magnesium in a pair of leaflets of the subtending leaf (μgm) at the beginning and end of the experiment was as follows

	After 21 days	After 49 days	
Cuttings in solution with Mg	139	435	Mean of 8 replicates
Cuttings in solution without Mg	127	102	

The appearance of the cuttings is shown in Fig 1, *B* on left, cuttings supplied with magnesium, on the right, cuttings grown without magnesium The leaves of the shoot without magnesium are almost devoid of chlorophyll, while the subtending leaf has remained healthy and without symptoms The experiment indicates that magnesium is not readily transported from the subtending leaf to the developing bud.

Potassium

Potassium is known to move freely about the plant, and as a check on the method a similar experiment was carried out with this element Leaf cuttings were taken from plants grown in full nutrient solution, and transferred after rooting either to full nutrient or potassium-deficient solution The potassium content (μgm) of leaflets of the mother leaf at beginning of the experiment and after forty-two days is shown below

	At start	After 42 days	
Cuttings in solution with K	264	673	Mean of 2 replicates
Cuttings in solution without K	276	164	Mean of 11 replicates

In contrast with the behaviour of manganese and magnesium, the potassium content of the subtending leaf has fallen considerably, and deficiency symptoms appeared not only on the axillary shoot but also on the mother leaf, the former showed brown areas of discoloration and bluish-green colour of the leaves, while the latter showed marginal scorch and necrotic interveinal areas.

STRUCTURE OF TOBACCO MOSAIC VIRUS

By Dr. ROSALIND E. FRANKLIN

Birkbeck College Crystallography Laboratory,
21 Torrington Square, London, W.C.1

TOBACCO mosaic virus is a rod-shaped virus, of (most frequent) length 3000 A.[1], diameter 150 A.[2], and molecular weight 50 million[1]. It contains 6 per cent by weight of ribonucleic acid, the remainder being protein. Many chemical and physico-chemical studies indicate that the tobacco mosaic virus protein may be built up of identical or nearly identical sub-units of low molecular weight[3–7]. A similar conclusion has been reached as a result of X-ray diffraction studies[2,8]. More recent X-ray work, the results of which are summarized here, provides further evidence for a protein sub-unit of molecular weight consistent with that obtained by chemical methods, and also gives more indication of the arrangement of the protein chains within the sub-unit.

Chemical Evidence

End-group determination using carboxy-peptidase indicates that all C-terminal amino-acids are threonine, and gives a minimum molecular weight of 17,000[4,5]. The amino-acid present in smallest quantity is cysteine. The cysteine content of tobacco mosaic virus is constant in all strains and corresponds to a minimum molecular weight of about 18,000[6]. The molecular weight of the protein fragments obtained by disintegrating the virus with sodium dodecyl sulphate has been given as 10,000–20,000[7], and here again the only C-terminal amino-acid is threonine[6].

Schramm[9] found N-terminal proline in amount corresponding to the C-terminal threonine, but Fraenkel-Conrat and Singer[7] showed that his analytical method was capable of breaking peptide bonds. Unable to detect any N-terminal amino-acid, these authors conclude that tobacco mosaic virus protein has a cyclic structure.

Several authors have shown[10] that, in certain circumstances, a protein of low molecular weight having properties similar to the protein obtained by degradation of tobacco mosaic virus is present in the sap of infected but not of normal plants. This protein has been shown to be capable of aggregating to form rods of the same diameter as the virus but free from ribonucleic acid, and to possess the serological properties of the virus.

Thus a large body of chemical evidence points to the existence in tobacco mosaic virus of a protein building unit of molecular weight between 10,000 and 20,000.

Helical Structure of Tobacco Mosaic Virus

Watson has suggested[8], on the basis of X-ray diffraction studies, that tobacco mosaic virus has a helical structure such that the virus particle can be considered as one giant helical molecule. By analogy with turnip yellow mosaic virus and bacteriophage *T*2, two very different viruses for each of which it is believed that the nucleic acid occupies a central position and is surrounded by a protein shell[11], he suggested that, in tobacco mosaic virus also, the ribonucleic acid may form a central core, around which lie molecules of globular protein in helical array.

Applying the theory of X-ray diffraction by helical structures[12] to the measured positions of the innermost intensity maxima on the layer-lines of the tobacco mosaic virus diagram, Watson concluded that the axial repeat period of 68 A. contains three turns of the helix, on which lie $3n + 1$ protein building units. The observation of an apparently meridional maximum on the 31st layer-line suggested that n was equal to 10. Using this value, and the results of Williams[1], the molecular weight of the protein building unit comes to 35,000—about twice that found by chemical methods.

Infra-red measurements[13] suggested that the protein might be in the form of Pauling α-helices[14] lying perpendicular to the axis of the virus, and Watson pointed out that the pitch of the virus helix, 23 A., would allow of a double layer of α-helices.

X-ray diffraction pictures with improved orientation and resolution have now been obtained, and studied in detail. The diagram shown in Fig. 1 is from a gel of approximately 25 per cent by weight of tobacco mosaic virus, contained in a thin-walled glass capillary of bore 0·4 mm. The intensity distribution on some twenty-five layer lines has been measured, and used for calculating the cylindrically averaged Patterson function shown in Fig. 2*a* and *b*.

The cylindrical Patterson function and the X-ray fibre diagram are simply two ways of presenting the same set of data; in attempting to interpret the data, it is often helpful to look at them in both forms. We shall consider first some information which can be derived by direct inspection of the X-ray diagram.

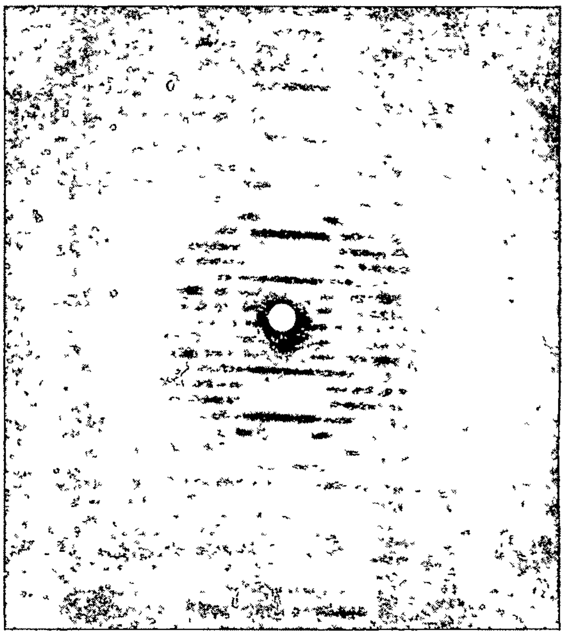


Fig. 1. X-ray diagram of tobacco mosaic virus gel. Orientated specimen obtained from N. W. Pirie's preparation of the virus, Rothamsted culture, incubated with proteolytic enzymes

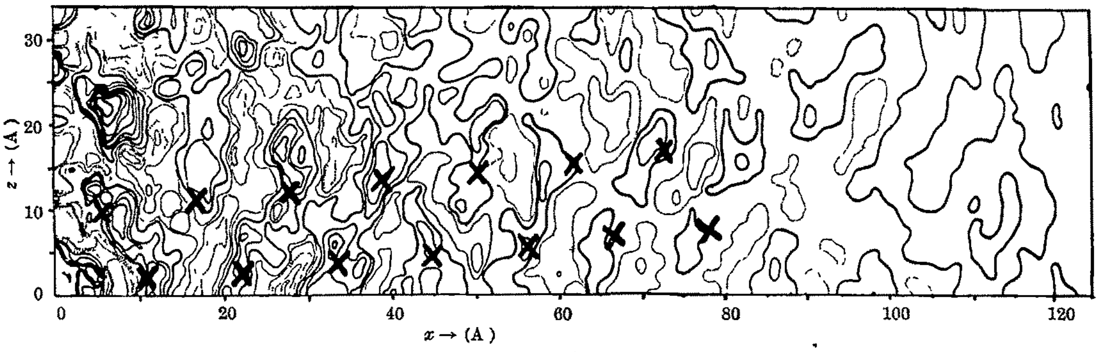


Fig 2a

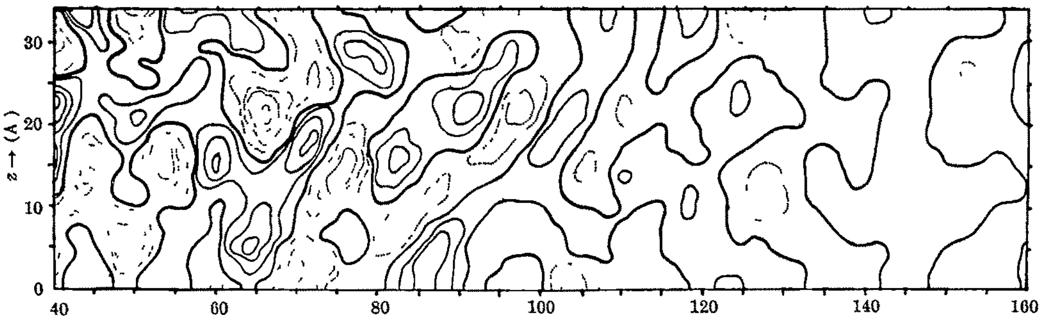


Fig 2b

Cylindrical Patterson function of tobacco mosaic virus For Fig 2b (large values of x) a strong 'artificial temperature factor' has been used

More accurate measurements of the positions of the first maximum on each layer line confirm most satisfactorily Watson's conclusion that there are $3n + 1$ units on three turns of the helix However, the maximum on the 31st layer line is found not to be truly meridional, but to have a value for ξ/λ of less than $30\,A^{-1}$. All other maxima stated by Watson to be possibly meridional have now been shown to be off-meridional. The only central maximum not yet resolved into two peaks lies on the 37th layer line, indicating that n may be 12. Although one cannot be sure that this peak, too, could not be resolved with further improvement of technique, and although in a complex structure it is always possible that the maximum looked for may be absent owing to phase-cancellation, it seems fair to state at the present stage that the most probable value of n is 12.

Assuming that there are $3n + 1$ units in three turns of the helix, then, from the observed positions of the innermost maxima on layer-lines of type $3m + 1$, $3m + 2$ (m any integer), an upper limit to n can be obtained In this way, the first observed maxima on the 1st and 11th layer-lines both show that n cannot possibly be greater than 14. Since observations have been made as far out as the 45th layer-line, this makes it unlikely that a strong central maximum on the layer-line $3n + 1$ has passed unobserved.

If n is 12, the molecular weight of the protein building unit is 29,000.

That it is difficult to be sure of the exact number of units per turn probably means that there is no great fluctuation in electron density in passing from one unit to the next on the same turn of the helix. The pitch of the helix, on the other hand, is quite unmistakable, and undoubtedly there is an important structural discontinuity in crossing from one turn of the helix to the next.

Shape of the Virus Particle

There is some evidence of an external grooving of the virus, the groove following the line of the helix. This is suggested, in the Patterson function, by the peak region lying between 135 and 155 A in x, a position corresponding with the known diameter of the particle. The shape of this peak, having necks at the base line and at the pitch height and bulging symmetrically on either side of these positions, can best be explained by supposing that the particle has a screw-like contour, and some slight excess of density at the surface (The excess surface density may well be due to extraneous matter, since the specimen was prepared by evaporation of a more dilute solution)

Further evidence of such grooving is provided by the 3rd layer line, the form of which shows that the outermost shell of the virus has very strong fluctuations of density with a period equal to the pitch of the helix. Again, grooving is the simplest explanation. This central region of the 3rd layer-line is found to be greatly modified in X-ray diagrams of air-dried orientated tobacco mosaic virus, as would be expected if the grooves are filled with water in the wet state and with air in the dry state

It has been suggested, as the result of electron microscope studies, that the cross-section of tobacco mosaic virus may be hexagonal[15]. If this were so, one would expect a dry specimen of the well-orientated virus to form a close-packed mass of uniform density We find, however, that strongly dried specimens show strong form birefringence (much higher than that of slightly damp specimens), and also very strong equatorial reflexions at spacings of about 70 and 50 A Both these observations show that there are holes between the particles in the strongly dried material, which is inevitable if the particle contour is helically grooved

Distribution of Scattering Matter within the Virus

We must now consider the shape of the protein building unit, and the distribution of scattering matter within it. Here some indication can be obtained from the Patterson function. It must be emphasized, however, that in the cylindrically averaged Patterson function of such a complex structure, it is probable that some important structural features will be entirely obscured, and others distorted. The interpretation here suggested, even if partially correct, certainly involves great over-simplification.

The array of peaks indicated by crosses in Fig. 2*a* suggests an end-on view of a double layer of rods of diameter 11 A This is consistent with the suggestion that the protein unit contains a double layer of α-helices running perpendicular to the axis of the particle. Moreover, the linearity of this long series of peaks suggests that the rods lie in a tangential rather than a radial direction with respect to the particle axis This type of arrangement is shown schematically in Fig 3

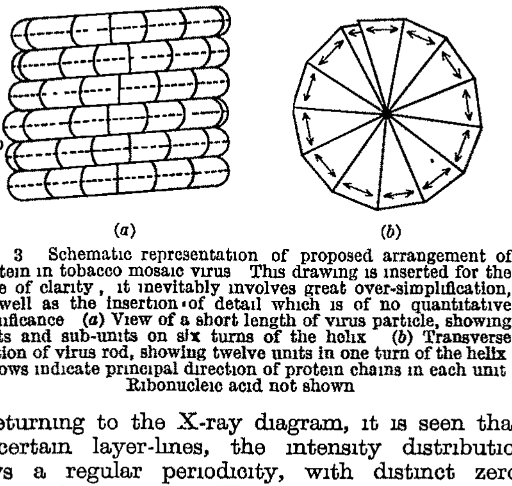

(*a*) (*b*)

Fig 3 Schematic representation of proposed arrangement of protein in tobacco mosaic virus This drawing is inserted for the sake of clarity, it inevitably involves great over-simplification, as well as the insertion of detail which is of no quantitative significance (*a*) View of a short length of virus particle, showing units and sub-units on six turns of the helix (*b*) Transverse section of virus rod, showing twelve units in one turn of the helix Arrows indicate principal direction of protein chains in each unit Ribonucleic acid not shown

Returning to the X-ray diagram, it is seen that, on certain layer-lines, the intensity distribution shows a regular periodicity, with distinct zeros between the maxima. This suggests that the projection of the structure on to an axial plane is approximately centro-symmetric (I am grateful to Dr. F. H. C. Crick for pointing this out), which again points to the sub-division of the main building unit of the helix into two near-equivalent parts related by a diad or pseudo-diad perpendicular to the axis of the particle, the complete structure of the protein being thus a combination of two equivalent co-axial helices

On the equator, the first four maxima lie close to those which would be given by a rod of uniform density of diameter 150 A. This, together with the regular periodicity of intensity, has made it possible to determine the signs of the first twelve equatorial maxima, and hence to calculate a Fourier projection of the virus. The most prominent feature of this projection (which will be presented and described in detail elsewhere) is a ring of high density at a radius of 55 A. This may suggest that the virus ribonucleic acid lies on this radius. An alternative explanation is that the ribonucleic acid in tobacco mosaic virus is heavily hydrated and lies at the centre, while the heavy shell of radius 55 A is simply a region of low hydration.

It is often supposed that there is no internal hydration in tobacco mosaic virus. However, when the air-dried virus is strongly dried at room temperature, there is a loss of weight of about 10 per cent Moreover, the scattered intensity on layer lines $3m + 1$ and $3m + 2$ becomes much weaker, showing that the degree of order within the protein building unit is reduced. This effect is comparable with the deterioration which occurs in the X-ray diagrams of single crystals of protein when the water of hydration is lost, and suggests that the virus protein also is to some extent hydrated

A detailed study of the 6th layer line in the tobacco mosaic virus diagram shows that the strong central region is mainly due to a second-order Bessel function contribution from a cylindrical shell of radius 55 A. This coincides with the high-density shell revealed by the Fourier projection, and it thus appears that the high-density shell must have a strong periodicity of 11 A. in the axial direction

To summarize, X-ray diffraction studies indicate that the protein of tobacco mosaic virus is in the form of structurally equivalent units of molecular weight about 29,000 arranged on a helix of pitch 23 A., there being $3n + 1$ such units on three turns of the helix, with n probably equal to 12. These units appear to be subdivided, along a plane approximately perpendicular to the axis of the helix, into two equivalent or near-equivalent sub-units. The molecular weight of these sub-units is consistent with the minimum molecular weight obtained by chemical methods

There is an important structural discontinuity between one turn of the helix and the next, and this appears to be associated with an external grooving of the particle This feature of the structure, which gives the virus a rather large external surface, may perhaps account for the surprising variety and extent of chemical modifications which it is possible to make in tobacco mosaic virus without breaking up the particle and, in some cases, without destroying its infectivity[16]. There is thus reason for hoping that further chemical work on the accessibility of the different amino-acids, together with X-ray studies of the chemically modified forms, may help to elucidate not only the configuration of the protein chains, but also the positions of certain amino-acids in the virus.

I am grateful to Prof J. D Bernal for his interest and encouragement, to Mr. N W Pirie for providing me with the purified tobacco mosaic virus, and to many American workers at Berkeley, Pasadena, St Louis and elsewhere, for stimulating discussions.

[1] Williams, R C, Backus, R. C, and Steere, R L, *J Amer Chem Soc*, **75**, 202 (1951)

[2] Bernal J D, and Fankuchen, I, *J Gen Physiol*, **25**, 111 (1941)

[3] Schramm, G, *Z. Naturf*, **2b**, 112 and 249 (1947)

[4] Harris, J I, and Knight, C A, *Nature*, **170**, 613 (1952)

[5] Harris, J I, and Knight, C A (private communication)

[6] Knight, C A, "Advances in Virus Research", **2**, 153 (1954)

[7] Fraenkel-Conrat, H, and Singer, B, *J Amer Chem Soc*, **76**, 180 (1954)

[8] Watson, J D, *Biochim Biophys. Acta*, **13**, 10 (1954)

[9] Schramm, G, and Braunitzer, G, *Naturforsch*, **8b**, 61 (1953)

[10] Takahashi W N, and Ishii, M, *Amer J of Botany*, **40**, 85 (1953) Commoner, B, Yamada, M, Rodenberg S D, Wang, T-Y, and Basler, E, *Science*, **118**, 529 (1953) Jeener, R, Lemoine, P, and Lavand'homme, C, *Acta Biochim*, *Biophys*, **14**, 321 (1954).

[11] Markham, R, Discuss. Faraday Soc, **11**, 221 (1951) Hershey, A D., and Chase, M, *J Gen Physiol*, **36**, 39 (1952)

[12] Cochran, W, Crick, F H C, and Vand, V, *Acta Cryst*, **5**, 581 (1952)

[13] Fraser, R D B, *Nature*, **170**, 491 (1952)

[14] Pauling, L, Corey, R B, and Branson, H R, *Proc U S Nat Acad Sci*, **37**, 205 (1951)

[15] Williams, R C, *Biochim Biophys Acta*, **8**, 227 (1952)

[16] Anson, M L, and Stanley, W M, *J Gen Physiol*, **24**, 269 (1941) Miller, G L, and Stanley, W M, *J Biol Chem*, **146**, 331 (1942) Knight, C A, *J Biol Chem*, **192**, 727 (1951)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The 'Horizon' of the Steady-State Universe

In a recent article on "The Age of the Universe" in *Nature*[1] there has been a call for a further explanation of the nature of the 'horizon' or the 'size' of the universe as it is defined in the steady-state theory. The subject is mathematically quite clear, and geometrical properties follow from the fact that the de Sitter space is the applicable one. Thus in the original papers on the subject by Bondi and Gold[2] and by Hoyle[3] there is no ambiguity. Pirani[4] has published a lucid mathematical discussion of the 'horizon', or the observable size of that type of universe. The present discussion is therefore merely a descriptive supplement.

There is no simple answer to the question: 'How big is that universe?' The theory is concerned only with quantities that can be measured observationally, or that could be so measured were it not for some obviously only technical limitation. Some of the questions that may be asked are discussed below.

(1) 'Out to what distance could we now see galaxies?' With any given observing apparatus of fixed limitations as to the energy density and the frequency of the light required for an observation, this will be a finite range. The number of galaxies that can be seen is then also finite. This will be so whatever the actual limits of the apparatus may be, so long as it requires finite amounts of energy for an observation. An improvement of the sensitivity of the apparatus would always give an increase of the range (but not in proportion).

(2) 'If we continued observations with a given apparatus for a very long time, what changes would we see?' In the course of time, the farthest galaxies that we could see will drop out of the observable set because their light will appear fainter and of lower frequency until it is below the threshold of the apparatus. At the same time other galaxies will become brighter as they grow bigger, and newly formed ones will become visible. Originally bright ones will fade towards the limit of observability. Statistically, the population will remain the same, though there will be losses and gains. The 'observational horizon' will always be at a finite range, constant for any given instrument, but greater the more sensitive the instrument.

(3) 'If we sent out a powerful light pulse now, where could it be received?' Such a signal will reach that set of galaxies which are at present nearer than a certain distance (given by Hubble's constant) from us. That is a finite number. But it will also reach all those galaxies that will have formed within the expanding space defined by the first set, in time to intercept the light. That is an infinite number. If reception is to imply recognition, and therefore a finite amount of energy at the receiver, this would limit the number to a finite one; but there is no limit in principle to the number of galaxies that could be informed of our pulse by the use of intermediate relay stations.

(4) 'Is there a last moment before which a light pulse has to be emitted here to assure its arrival at a specified galaxy?' Yes. If the signal is sent later than that moment it will not get to that galaxy. (This is not a question of observational technique.)

(5) 'Is there a last moment for the reception of light signals from another galaxy?' No. There is no last moment of reception defined in the theory. The last signal emitted by another galaxy that could be received here would, however, be drawn out in time so that it would take an infinite time for it to arrive, however short a pulse it may have been at its emission. This absence of a defined instant at which reception must cease does not mean that the act of disappearance is in doubt, but only that the moment at which it occurs is related to the particular method of observation. A change to more sensitive methods of observation would delay the disappearance of any one galaxy, but provided the method of observation is kept the same, the mean rate of disappearance from view will be constant (and equal to the rate at which new ones are appearing in the realm surveyed by that instrument).

So far as any actual, or in principle possible, observation is concerned, that universe is finite. The flow pattern of information there is analogous to that in a population which has a finite number of members at any instant, but which is in a steady state for all time. If I were a member of such a population I could obtain information (say, in writing) from an unlimited set that have lived before now, and I could leave information for an unlimited set in the future. But there would only be a finite number with whom I could now have a two-way conversation. Any one of that number will also belong to one, or more generally to both, the unlimited sets.

T. Gold

Royal Greenwich Observatory,
Herstmonceux Castle,
Hailsham, Sussex.

[1] *Nature*, **175**, 69 (1955).

[2] *Mon. Not. Roy. Astro. Soc.*, **108**, 252 (1948).

[3] *Mon. Not. Roy. Astro. Soc.*, **108**, 372 (1948).

[4] *The Observatory*, **74**, 172 (1954).

Mr. Gold's statement is very clear, and those interested in cosmology will be very grateful to him for making it. Unfortunately, however, it only increases the uncertainty which has arisen regarding the actual implications of the theory with respect to the observable horizon, since it appears to be in direct conflict with statements made in the paper by Hoyle which Mr. Gold now cites as one of "the original papers on the subject". In that paper Hoyle says: "Extragalactic nebulæ are continually passing out of the observable universe . . . The oldest condensation within the observable universe . . . has an age of about 1.5×10^{10} years". If a nebula passes out of the observable universe there must have been a time when it was within it (that is, was observable), and a later time when it was not observable. Hence there must have been a time when it ceased to be observable. But Mr. Gold now says: "Is there a last moment for the reception of light signals from another galaxy? No. There is no last moment of reception defined in the theory".

It is clear from Hoyle's paper that the "passing out of the observable universe" was not introduced as an effect of instrumental imperfections: it has been generally interpreted as an effect of the nebula reaching, at a finite distance and within a finite time, the velocity of light. Statements to this effect are numerous. For example, Dingle, speaking in February 1953, assumed that the theory required that "nebulæ are continually receding into inaccessibility by surpassing the speed of light"[1]. Still earlier, in May 1952, the Astronomer Royal, in describing the theory at a Friday Evening Discourse at the Royal Institution[2], said that "at a distance of about two thousand million light years the rate of expansion becomes equal to the velocity of light. At that distance we have, therefore, an observational horizon, beyond which we can never see. . . . As the creation of matter is at the rate needed to keep the mean density of matter in the Universe constant, the rate at which galaxies are being born just balances the rate at which they are lost to view". Neither of these statements, which Mr. Gold's letter now contradicts, seems ever to have been corrected.

If, as Mr Gold now says, "A change to more sensitive methods of observation would delay the disappearance of any one galaxy", what is the meaning of Hoyle's statement that "the oldest condensation within the observable universe . . . has an age of about $1·5 \times 10^{10}$ years"? What particular method of observation corresponds to this figure?

In view of these and other questions that will doubtless arise when the whole matter is reviewed in the light of Mr. Gold's new explanation, the need seems imperative for a clear and authoritative statement either reconciling the earlier and later assertions or else stating which is to be accepted as the true postulate of the theory.

THE WRITER OF THE ARTICLE

---

[1] *Mon Not Roy Astro Soc*, 113, 404 (1953)
[2] *Proc Roy Inst*, 35, 336 (1953)

Influence of Liquid Films on Fibre Friction

Bowden and Tabor[1] have shown that the adhesive force between a smooth sphere and a smooth plane due to a surface film of liquid is independent of the amount of liquid held between the surfaces. This is not true for the case of a cylinder in contact with a plane, when the adhesive force per unit length of cylinder is

$$A = 4\nu\sqrt{R/r}, \qquad (1)$$

where R is the cylinder radius, r the radius of curvature of the liquid meniscus and ν the surface tension. According to (1), A will increase as r is reduced by decreasing the amount of liquid present. The adhesion will not become infinite, but its maximum value will be determined by the tensile strength of the liquid or by the surface roughness.

The effect is easily demonstrated for a relatively thick glass fibre adhering to a glass plate by adding water and measuring the adhesion as the water evaporates. With a fibre 0·1 cm. in diameter, values of A up to 2 gm./cm. are readily obtained. The adhesion cannot, however, be measured directly in this manner for fine textile fibres, but it can be measured indirectly in so far as it modifies the apparent frictional coefficient when rubbing takes place on a smooth surface in the presence of a liquid film.

Fibre frictional coefficients are generally measured by the 'bollard' method for which the well-known relation,

$$T_1/T_2 = \exp \mu_A \theta, \qquad (2)$$

is employed, where T_1,T_2 are the fibre tensions, θ is the angle of contact between fibre and cylinder and μ_A the coefficient of friction. In the presence of an adhesion force A, relation (2) will take the form,

$$\frac{T_1 + A\rho}{T_2 + A\rho} = \exp \mu\theta,$$

when ρ is the cylinder radius and μ the true coefficient of friction. Then by measuring values of T_2 for two different values of T_1, it is possible to determine both A and μ. Some results obtained using a nylon fibre and a polished glass cylinder are shown in Table 1. No attempt was made to fix the thickness of the oil film, which was simply reduced in thickness by wiping with a clean cloth. The oil used had a viscosity of about 1 c.g.s. unit and a surface tension of about 30 dynes/cm., the cylinder diameter was 5·9 cm.

Table 1

Oil film	μ	A	μ_A, from (2)
As originally applied	0·4	0·10 gm./cm	0·62
Cylinder wiped once	0·4	0·17 gm./cm	0·79
Cylinder wiped again	0·4	0·26 gm./cm	1·10

In the case of the thinnest oil film, the experiment was repeated using a wool fibre, and the values $\mu = 0·4$ and $A = 0·03$ gm./cm were obtained.

It is plain that the surface roughness of the wool fibre resulting from the surface scales has eliminated adhesion effects to a large extent.

G. KING

Wool Industries Research Association,
Torridon,
Headingley, Leeds 6.
Nov. 4.

---

[1] Bowden, F. P., and Tabor, D., "The Friction and Lubrication of Solids", 300 (Clarendon Press, 1950)

Non-linear Microphonic Response of Labyrinth Organs to Stimuli consisting of Two Pure Tones

IN a study of the microphonic effect of the lateral line of fishes[1], we found a remarkable response to a stimulus consisting of two pure sine waves acting at the same time on the sense organ. These effects are demonstrated by Fig. 1, curves *A*–*C*.

The most interesting aspects of these curves are (1) The frequency of the response (*A* and *B*) is twice the frequency of the stimulus. (2) In the combined effect (*C*), the response to the high frequency is large at the negative peaks and small at the positive peaks, the latter correspond (approximately) to the equilibrium position of the organ. (3) The maximum response to the high frequency in *C* is much larger than if this frequency is presented alone (*B*), with the same amplitude. The quotient of the two responses will be called the 'amplification'. This amplification depends on the amplitudes of *a* and *b*.

We are still convinced that the explanation of the double frequency given in our earlier paper[1] is correct. It is not found in the microphonic effect of the cristæ of the semicircular canals and of the

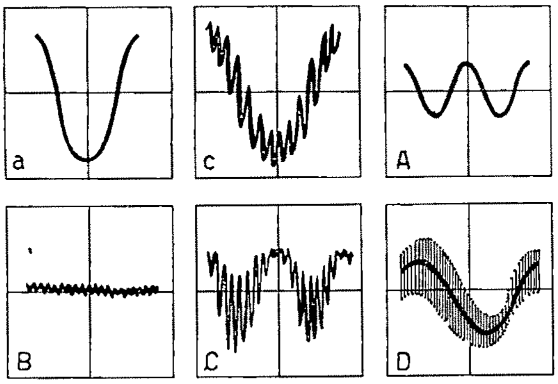


Fig 1 Curve *a* Waveform of the low frequency *c* Waveform, if a high frequency with smaller amplitude is superimposed on the low frequency *A* Response of the lateral line organ to stimulus *a* (double frequency) *B* Response to the high frequency alone (Oscillogram *B* was photographed for another frequency, but it has the right amplitude) *C* Response to *c* *D* Response of a labyrinth organ to stimulus *c* (schematical)

cochlea The further quantitative analysis of the phenomena, however, revealed fundamental difficulties in the explanation which was given for the effects under (2) and (3). This will be described in more detail in the thesis of one of us (J. W K). Hence it seems probable that these two effects are due to the sense cells themselves, so that the labyrinth organs should also give a similar response. Indeed, this was checked for the cristæ of the semicircular canals as well as for the cochlea of the pigeon by one of us (D R U) This has now been checked for mammals with positive result.

There are some minor differences between the cochlea and the other organs studied. Though in all cases a 'zero-point' in the output for the high frequency is found, it is generally on the rising part of the curve for the cochlea, whereas it is sometimes on the descending part of the curve for the cristæ. For the lateral line it is close to the top of the curve. The optimal 'amplification' (see above) is about 6 for the lateral line, between 3 and 8 for the cristæ and between 1 and 1 7 for the cochlea It is about 1 for less optimal values of the amplitudes of the two frequencies.

Though the experiment described here is very simple, we have not found any earlier report of it in the literature It proves that the sense organ gives a non-linear response, a good microphone should give a response similar to the input curve *c*. We have constructed electronic models giving the same typical response, and the possible relations between these models and physiological processes are being investigated. They will be published elsewhere in more detail, together with a full account of the experiments described here

Our thanks are due to Prof. Eelco Huizinga, director of the Otological Clinic, for his interest

Hl de Vries
J W. Kuiper

Physical Laboratory,
Department of Biophysics,

D. R. Ubbens

Otological Clinic,
University of Groningen.
Oct. 16.

---

[1] de Vries, Hl, Jielof, R, and Spoor, A, *J Physiol*, 116, 137 (1952)

Interpretation of Differential Thermal Curves of Mixed-layer Minerals of Illite and Montmorillonite

Mixed-layer minerals of illite and montmorillonite have been known for more than a decade now, and new examples are constantly being reported[1] The identification of these minerals is based largely on X-ray examination using the tables and curves of Brown and MacEwan[2] or the method of MacEwan[3] for random structures, the methods for ordered structures are more direct. Most workers publish differential thermal curves as supporting evidence for the presence of an interlayered structure, and in these curves there are usually two endothermic peaks in the region between 500° and 700° C, which are taken to represent loss of hydroxyl water from the separate illite and montmorillonite layers. However, a detailed examination of published and unpublished differential thermal curves of these materials shows that the sizes of the endothermic peaks in the 500°–700° C. region bear no relation to the proportion of illite to montmorillonite found by X-ray examination Order can be attained only by dividing the curves into two series, in one of which the main endothermic peak lies between 525° and 625° C. and in the other between 650° and 725° C. The curves in each series still bear no relation to the proportion of illite and montmorillonite, but there is an important structural difference between the groups not revealed by X-ray examination which appears to be of wide significance.

The subdivision requires the existence of anomalous illites[4] and montmorillonites[5] in which the temperatures of the endothermic peaks are reversed in the region between 500° and 700° C. Furthermore, it is logical to assume that these anomalous minerals have arisen owing to mineral transformations that have proceeded as in the following scheme (full lines).

Series I		Series II
'Illite'-like differential thermal curves		'Montmorillonite'-like differential thermal curves
Structure probably disordered		Structure probably ordered
	← – – –	
↓ Normal illite		Abnormal illite ↑
Intermediates		Intermediates
Abnormal montmorillonite		Normal montmorillonite
	– – – →	

If this thesis be correct, differential thermal analysis will indicate the direction in which mineral transformations are taking place in mixed-layer minerals of illite and montmorillonite; several examples have been put to test with success

Transformations between series I and II are possible but difficult, thus explaining why the second endothermic peak associated with the main one in the region 500°–700° C. in each series is usually poorly developed. It can be performed artificially for a normal montmorillonite by firing material to 800° C. and rehydrating the product in steam[6], whence abnormal montmorillonites are obtained. It should be noted that this is a disordering process and suggests the possibility that the structures of series I are disordered and those of series II ordered. Order–disorder can be of several types and need not be the same for artificially prepared abnormal montmorillonites as for naturally abnormal ones. That which is believed to be of importance for the latter is order–disorder of the substitution cations, which brings about differences in bonding of hydroxyls as indicated by Kerr *et al* [7].

On the present theory it would not be necessary for the abnormal montmorillonites recently described by Bose and Sengupta[5] to have iron contents intermediate between that of nontronite and normal montmorillonite to explain the lower differential thermal peak in the region 500°–700° C. Another naturally abnormal montmorillonite known to me has no iron at all, and the iron content of the sample used by Hill[6] could not have been changed during his experiments. Chemical data indicate also that current theories of the effect of substitution of silicon by aluminium in tetrahedral layers do not explain the thermal effects of anomalous illites and montmorillonites. A disorder–order process seems worthy of serious consideration and study

In the scheme suggested, a cycle of transformations is postulated, and this cycle should be reversible, but as yet no ways of performing the disorder–order transformation artificially have been found. However, this concept should enable one to plan experiments designed to transform illite and montmorillonite (normal forms) into each other more successfully than has been done in the past.

A more detailed account of these ideas is given in a chapter on clay mineral mixtures and mixed-layer minerals in the forthcoming monograph of the Mineralogical Society of Great Britain on "The Differential Thermal Investigation of Clays".

W F COLE

Division of Building Research
(Commonwealth Scientific and
Industrial Research Organization),
Graham Road,
Highett, S.21, Victoria.
Sept. 27.

[1] Bystrom, A M, *Nature*, 173, 783 (1954) Cole, W F, and Carthew, A R, *J Roy Soc Tas*, 87, 1 (1953) Heystek, H, *Min Mag*, 30, 400 (1954) Weaver, C E, *Bull Geol Soc Amer*, 64, 921 (1953)

[2] Brown, G, and MacEwan, D M C, in "X-Ray Identification and Structures of Clay Minerals", edit G W Brindley, 266 (1950)

[3] MacEwan, D M C, *Nature*, 172, 364 (1953)

[4] Mackenzie, R. C, Walker, G F., and Hart, R, *Min Mag*, 28, 704 (1949)

[5] Bose, A. K, and Sengupta, P, *Nature*, 174, 40 (1954)

[6] Hill, R. D., *Trans Brit Ceram Soc*, 52, 589 (1953)

[7] Kerr, P F, Kulp, J L, and Hamilton, P K, "Differential Thermal Analysis of Reference Clay Mineral Specimens", Report 3, American Petroleum Institute Project 49 (Columbia University, New York, 1949)

Anhydrous Hydrogen Fluoride as a Collagen Solvent

IT has been reported[1] that hide collagen and other proteins dissolve in anhydrous hydrogen fluoride The fact that some proteins, like insulin, were recovered with up to 80 per cent of their initial biological activity, after solution in this solvent, suggested that collagen might dissolve without denaturation. The ability to reconstitute characteristic collagen fibrils from solution was used as the criterion of the absence of denaturation

Dry, purified, unlimed, steer-hide collagen was introduced into the middle flask of a train of three polyethylene flasks. These flasks were connected to each other, to the hydrogen fluoride tank, and to a nitrogen tank by polyethylene and copper tubing to form a gas-tight apparatus. After introduction of the sample, the apparatus was flushed with dried nitrogen for 48 hr. Hydrogen fluoride was distilled from the tank into the nearest flask and then carefully redistilled into the flask containing the sample After eleven days at 0° C., some of the collagen had dissolved Using anhydrous conditions, some of the supernatant liquid was withdrawn into a fourth polyethylene flask The hydrogen fluoride was evaporated from the two flasks anhydrously and the residues examined

The residue from the supernatant liquid was a transparent film which gave a gelatin-like high-angle X-ray diffraction diagram. This dry film was soluble in water. A distilled water solution of this film produced precipitates when ammonium sulphate and phosphotungstic acid solutions were added These precipitates were examined in the electron microscope but nothing fibrous was observed.

The distilled water solution was further examined by dialysis against 1 per cent and 10 per cent solutions of sodium chloride, tap water and distilled water. Bovine glycoprotein was added to another portion, and this mixture was dialysed against distilled water[2]. Precipitates were not obtained in these reconstitution tests, and nothing fibrous was seen on electron microscopic examination

We conclude that anhydrous hydrogen fluoride does dissolve steer hide collagen, but that the solution occurs with denaturation

RUSSELL E DREIKORN
VINCENT O'GORMAN

Research Division,
United Shoe Machinery Corporation,
Beverly, Massachusetts.
Oct. 20.

[1] Katz, J J, *Nature*, 173, 265 (1954)

[2] Highberger, J H, Gross, J, and Schmitt, F O, *Proc U S Nat Acad Sci*, 37, 286 (1954)

Reactions of Hyponitrites and Nitrites

EXPERIMENTS carried out by Oza and Oza[1] with silver and anhydrous strontium hyponitrites and dinitrogen tetroxide at 0°, 30° and 140° C show the production, in the gas, of both nitrous oxide and nitrogen, which are among the thermal decomposition products of these hyponitrites It appears, therefore, that these hyponitrites undergo fission into their normal decomposition products under the impact of the molecules of nitrogen tetroxide or dioxide The oxide and the nitrite so formed then react with the nitrogen tetroxide or dioxide to yield their relevant products of the reaction, while the gaseous products of the primary fission remain unaltered and their presence is shown by analysis of the gas.

It is known that sodium hyponitrite decomposes as follows.

$$3Na_2N_2O_2 = 2Na_2O + 2NaNO_2 + 2N_2$$

The hydrated salt produces some nitrous oxide also[1]. Thus the mere presence of water has the effect of converting some of the nitrogen into nitrous oxide. Calcium hyponitrite tetrahydrate, which normally decomposes into nitrite, nitrate, oxide, nitrous oxide, nitric oxide and nitrogen at 330°, is shown to decompose, yielding the same products, when kept for some time in the vicinity of 100° It appears, therefore, that the decomposition of hyponitrites can be induced by causes other than heat, for example, by molecular agitation of some kind. The hyponitrites of strontium, silver and mercury have also been systematically investigated by Oza and Thaker and found to yield similar products when decomposed by heat.

In another investigation silver oxide was isolated in the decomposition products of silver nitrite, although it had not been found by E. Divers[2]. The probable formation was indicated in a thesis mentioned in *British Chemical Abstracts* (1, 245 , 1942) , the details were not published and reference to the thesis shows that the oxide was isolated when silver nitrite was heated in a current of dry air at 550°, when the decomposition is extremely rapid His silver oxide may have been a secondary product , silver, in a finely divided state, can react with the oxygen of the air[3]. Oza, Oza and Thaker have isolated silver oxide in the decomposition of silver nitrite at 130° in an atmosphere of oxygen at 11 cm. mercury pressure. Addition of finely divided silver to the decomposing nitrite did not alter the results It is obvious that the atmosphere immediately in contact with the decomposing nitrite is a mixture of nitrogen dioxide and oxygen, which can produce only nitrate but not oxide. The presence of oxygen in the atmosphere surrounding the decomposing nitrite has the effect of removing nitric oxide, a product of the decomposition, which, if left as such, destroys the silver oxide

The action of nitric oxide on oxides of silver, mercurous and mercuric mercury, and calcium has been investigated by Oza and Thaker and Oza and Oza. The oxides were heated, at suitable temperatures ($< 300°$), for varying periods of time, in an atmosphere of nitric oxide at different pressures The experiments demonstrated the formation of nitrite as the primary product of the reaction. Nitrogen and nitrogen dioxide are produced in the gas and their formation is greatest when nitric oxide is at a pressure tending to zero There seems little doubt, therefore, that the molecule of nitric oxide decomposes and the nitrogen dioxide found in the gas arises in this way. The formation of nitrite may also involve a prior orientation of the nitric oxide molecule on the surface of the metal oxide to bring about what is essentially a peroxide structure[4] Nitrogen is also formed from nitric oxide in contact with nitrite[1]. In the case of silver oxide, which has, among the oxides now studied, the most readily detachable oxygen, this provides the most noteworthy reactions

TRAMBAKLAL MOHANLAL OZA

Institute of Science,
Bombay 1
Oct. 20.

[1] Oza, T M , and Oza, V T , *J Chem Soc* , 909 (1953)

[2] Divers, E , *J Chem Soc* , 24, 85 (1871)

[3] Benton, A E , and Drake, L C , *J Amer Chem Soc* , 54, 2186 (1932)

[4] Addison, C C , and Lewis, J , *J. Chem. Soc* , 1874 (1953)

A Simple Method for the Determination of Glycogen in Liver

THE methods used for the determination of liver glycogen can be divided into two general groups the glycogen can be determined in its original state[1,2], or after its hydrolysis to form simple sugars[3,4].

Recent investigations indicate that liver glycogen is built up of two physiologically different components. One of these is protein-bound, constant and can be extracted by boiling with alkali. The other is 'free', and physiological alterations are mainly associated with this fraction, which can be extracted with trichloracetic acid[2,5]. The latter method has been recently regarded by several authors as an accurate method for the determination of quantitativ changes in the liver glycogen[2,6,7].

On the basis of our experiments carried out during the past year, we recommend the following method for the determination of glycogen. We use 10 pe cent (v/w) trichloracetic acid, physiological salin and absolute alcohol. 2–3 gm. aliquots of the liver of rats killed by decapitation are quickly homogenized in a mortar previously weighed and containing 2 ml of trichloracetic acid. The weight o the liver sample is established by reweighing th mortar, and the quantity of trichloracetic acid mad up to 1 ml /gm liver To this 1 ml./gm liver mixture physiological saline is added and the homogenization completed. After filtration through filte paper, 1 5 ml. of alcohol is added to 1 2 ml. of th filtrate (In the case of high liver-glycogen concentrations, appropriate dilutions of the filtrate may be used) The turbidity arising on shaking and after standin for three hours is measured nephelometrically wit a yellow filter in a suitable colorimeter The origina (or the diluted) filtrate in a 1 2–1 5 dilution wit water serves as blank control

Calibration curves were established with dilution of a commercial sample of glycogen and with thre samples originating from different groups of rat liver The regressions of all the four samples proved to b identical. This shows a great advantage above th van der Vies iodine method[2], as with the latter eve livers of single animals of the same species gav different colour reactions. We have ourselves investigated the use of this method[8].

In recovery experiments, 103 6 ± 3 85 per cen of added glycogen was regained (average of nine determinations) The values obtained by our metho were compared with the values for the same live as determined by the hydrolytic method[3,9] Accordin to our experiments, in the case of low liver glycoge the relative proportion of trichloracetic acid glycoge proved to be low, whereas in the case of high live glycogen the two methods gave nearly the sam results. This observation is in accordance with th results of other authors[2,10].

Details of this work will be published in *Act Physiologica Acad. Sci. Hung*

L. GYERMEK
G. FEKETE

Pharmaco-Industrial Research Institute,
Budapest.

[1] Wagtendonk, W J van, Simonsen, B H , and Hatchett, P I *J Biol Chem* , 163, 301 (1946)

[2] van der Vies, J , *Biochem J* , 57, 410 (1954)

[3] Good, C A , Kramer, H , and Somogyi, M , *J Biol Chem* , 10 485 (1933)

[4] Seifter, S , *et al* , *Arch Biochem* , 25, 19 (1950)

[5] Merrick, A W , and Mevor, D K , *Amer J Physiol* , 177, 441 (195

[6] Kleij, B J van der, *Biochim Biophys Acta*, 7, 481 (1951)

[7] Bloom, W L , *et al* , *J Biol Chem* , 188, 631 (1951)

[8] Gyermek, L , and Fekete, G , *Acta Physiol Acad Sci Hung* (in t press)

[9] Nelson, N , *J Biol Chem* , 153, 375 (1944)

[10] Kerly, M , and Ottawav, I H , *J Physiol* , 123, 516 (1954)

In vitro Synthesis of Ribonucleic Acid in Reticulocytes

WE have been studying the concurrent synthes *in vitro* in rabbit reticulocytes of hæm, globin an the non-hæmoglobin proteins. Using methylen labelled (^{14}C) glycine the degree of ribonucleic ac synthesis also could be measured. The techniq devised may be useful to others faced with th problem of measuring the radioactivity of very small amounts of substances in very dilute solution It has enabled us to observe the synthesis of five nucleotide components of ribonucleic acid, beginning with 8 ml. of reticulocytes

Reticulocytes were produced in a rabbit by the injection of phenylhydrazine, these were washed free of plasma in Krebs solution by centrifugation, and then incubated for two hours at 37 5° under 95 per cent oxygen and 5 per cent carbon dioxide in a Krebs solution reaction mixture containing the following, which have been found to stimulate amino-acid incorporation into the proteins and hæm synthesis certain amino-acids, Fe^{++}, fructose-alanine, and plasma dialysate[1] At the end of the incubation, the cells were washed five times by suspension and centrifugation in a large volume of Krebs solution and then to the sedimented cells was added 100 ml of 7 per cent trichloracetic acid at 4° which dissolves all the free nucleotides The precipitate was dissolved in 1 *N* sodium hydroxide (0 25 ml per ml. of cells used) and allowed to stand overnight at room temperature The ribonucleic acid is thus hydrolysed to its nucleotides The deoxyribonucleic acid and proteins are precipitated from this solution by 7 per cent trichloracetic acid The supernatant solution is extracted with ether in order to remove the trichloracetic acid and then the Na^+ is removed from it by the addition of 20 mgm of 'Dowex-50' H^+[3] The nucleotides were then isolated by adsorption on, and serial elution from, 'Dowex-1' according to the procedure of Cohn[4] Cytidylic and adenylic acid *a* were eluted with 0 1 *M* formic acid, adenylic acid *b*, guanylic and uridylic acids by 1 0 *M* formic acid The fractionation was followed by measuring the light absorption at 260 mμ and the different nucleotides were identified by the ratio of optical densities at 260 and 280 mμ.

The following procedure was used for measuring the radioactivity of each nucleotide isolated as above 20 mgm. of 'Norit' was suspended in water and then spread evenly on a circle of filter paper, 20 mm diameter, by suction filtration through a sintered glass funnel with a removable collar. The solution containing the nucleotide was filtered through several times until no more nucleotide was removed. The amount of nucleotide adsorbed was determined by the diminution in optical density at 260 mμ in the filtrate, 20 mgm of 'Norit' retains about 1 mgm of nucleotide. For accurate measurement of the radioactivity the charcoal must be saturated with nucleotide, therefore the filtrate must finally contain some nucleotide which the charcoal does not remove. It was determined in separate experiments that no free glycine (^{14}C-labelled) was retained on the charcoal in this procedure, this eliminated any possible slight contamination of the 'Dowex-1' fractions by radioactive glycine The paper with the charcoal on it was then placed on a circular aluminium cup, spread with silicone grease to prevent curling of the paper, and dried Radioactivity was measured in a Geiger–Muller end-window counter, using glycine with 24 $\times 10^{6}$ counts per minute per millimole

The different nucleotides have the following specific activities

Nucleotides	Counts/minute per millimole
Adenylic acid *a*	2,620
Adenylic acid *b*	2,295
Guanylic acid	3,620
Cytidylic acid	1,135
Uridylic acid	515

This incorporation is about 1–6 per cent of the incorporation of glycine per residue of glycine in the globin.

J Kruh*
H Borsook

California Institute of Technology,
Kerckoff Laboratories of Biology,
Pasadena, California

Oct 4

---

* French Government and Fulbright Fellow Present address Laboratoire de Recherches de Biochimie Médicale, Hôpital des Enfants Malades, 149 rue de Sèvres, Paris

[1] Borsook, H, Abrams, A, and Lowy, P H, *J Biol Chem* (submitted for publication)
[2] Borsook, H, Deasy, C L, Haagen-Smit, A J Keighley, G, and Lowy, P H, *J Biol Chem*, 196, 669 (1952)
[3] Loring, H S (personal communication)
[4] Cohn, W E, *J Amer Chem Soc*, 72, 1471 (1950)

Relation of the Ground Substance of the Central Nervous System to the Blood – Brain Barrier

Between the cell bodies, the neuroglial fibres, and the nerve processes of the central nervous system, there are spaces These spaces are filled with a ground substance of a carbohydrate – protein nature, revealed by staining with the periodic acid – Schiff reagents[1] The concept of a blood – brain barrier was formulated when it was discovered that intravenously administered trypan blue stains extensively other organs of the body, but does not stain the brain[2]. Numerous subsequent investigations have demonstrated that trypan blue, administered intravenously or intraperitoneally, is a valid test substance for the presence or absence of a blood – brain barrier[3].

Intravenous trypan blue does not stain the adult brain[2], indicating the presence of a blood – brain barrier. On the other hand, intravenous trypan blue stains the brain in several new-born animals, indicating the absence of such a barrier[4] The brain of the new-born mouse has not yet developed a blood – brain barrier and hence stains with trypan blue[5]. Periodic acid – Schiff staining of paraffin sections of the brains of neonatal mice reveals that the ground substance is not yet present in these forms The brain of the new-born guinea pig already has a blood – brain barrier[4] and, like the adult, does not stain with trypan blue[6] It has been shown that the ground substance of the guinea pig brain is present already in the fœtus at 45 days of gestation, and assumes proportions similar to the adult at 50 days gestation age[7]. Thus, the absence or presence of a blood – brain barrier as tested by the ability of the brains of animals to stain or not to stain with intravenous trypan blue appears to be related to the absence or presence of the ground substance of the central nervous system

To test this hypothesis further, experiments were performed on the brains of rats Hot-stab wounds of the brains of adult rats allow the brain to be stained by intraperitoneal trypan blue[8], thus implying a breakdown of the blood – brain barrier[3] The stain is most intense after operation and until three days after injury, after which it gradually fades and is essentially absent ten days after operation[8]. Stab wounds with a hot needle were made in the brains of adult rats After one to thirty days, the animals were killed and sections through the wound area were stained by the periodic acid – Schiff technique. After a stab wound of the brain, an extensive area of brain surrounding the wound is negative to the periodic acid – Schiff test. This condition lasts for three days After three days, the negative area around the wound begins to diminish in extent. This continues until ten days after the operation, by which time it has disappeared After such brain wounds, the ground substance disappears, begins to be re-elaborated starting at the third day, and gradually increases in amount until its regeneration is about complete by the tenth day. Thus after brain wounds, the breakdown and reconstitution of the blood – brain barrier, as tested by intraperitoneal trypan blue staining, conforms to the same schedule as the dissolution and re-elaboration of the ground substance

The site of the blood – brain barrier has been said to reside in the cerebral capillaries, in the capillary endothelium, or in the pia-glial membrane From the results of the present experiments, it seems that the ground substance of the central nervous system contributes to the blood – brain barrier and is a substance which prevents the staining of the adult normal brain by intravenous or intraperitoneal trypan blue.

These experiments will be reported in detail shortly. This investigation was supported in part by research grant B-341 from the Institute of Neurological Diseases and Blindness of the National Institutes of Health, U S Public Health Service.

ARTHUR HESS

Department of Anatomy,
Washington University School of Medicine,
St. Louis, Mo
Oct. 26.

[1] Hess, A , *J Comp Neurol*, 98, 69 (1953)
[2] Goldmann, E E , "Vitalfärbung am Zentralnervensystem" (Georg Reimer, Berlin, 1913)
[3] King, L S , *Arch Neurol and Psychiat*, 41, 51 (1939)
[4] Stern, L , and Peyrot, R , *C R Soc de Biol*, 96, 1124 (1927)
[5] Behnsen, G , *Z Zellforsch u mikr Anat*, 4, 515 (1927)
[6] Broman, T , *Acta Psychiat Neurol*, 16, 1 (1941)
[7] Hess, A , *J Comp Neurol* (in the press)
[8] Macklin, C G , and Macklin, M T , *Arch Neurol and Psychiat*, 3, 353 (1920)

Effect of Methylcholanthrene on Ovaries of Mice

ALTHOUGH a great deal of work has been done on the carcinogenic action of methylcholanthrene, its effects on specific organs and tissue systems have not been completely investigated Among the methods employed are skin-painting, subcutaneous injection, intra-peritoneal administration as well as injection into the amniotic fluid of mice. The findings reported here are based on observations by another method which has been employed as part of an investigation for determining the strain specificity of certain endocrine organs of mice of the C_{57} (black), the Strong A and the C_3H (Bar) strains of mice The results which were obtained are striking enough to deserve wider notice even at this stage

Female mice of the three strains about two months of age were operated upon under anæsthesia and the ovaries exposed. Each ovary was gently lifted up with a pair of forceps and painted with a 0 25 per-cent benzene solution of methylcholanthrene with a single stroke of a camel hair brush. The ovaries were then dropped back in place and the abdominal wound sutured up. When the sutures healed, the animals were kept for mating with their respective litter-mate males.

It has been observed that an over-all hæmorrhagic effect is seen in the young of all the strains and in particular the C_3H (Bar) strain Localized hæmorrhagic areas are seen in all and particularly in the C_{57} strain These areas are almost always on the upper lip, the back between the scapulæ, the shoulders, and the legs especially the digits. Blood clots have been observed in the C_{57} (black) and the Strong A strains These are at the tip of the nose, the chin, on the digits and in some cases at the second joint of the limbs. One or several may be present in a single animal. In the Strong A strain, one young with a club foot was observed. This animal lived to be eleven days old, at which time the mother destroyed it. Histological sections have shown that the hæmorrhage is not in any particular region but diffused throughout the connective tissue and muscles Table 1 gives a summary of the reactions seen in the different strains

From the observations available so far, it seems as though the ova of each strain respond differently to methylcholanthrene The effect on the C_{57} (black) seems to be most drastic, while in the Strong A it is least lethal On the C_3H Bar it appears to be intermediate in action It would seem as though the effect on the ova persists, for the reaction is obvious not only in the first litter but also in subsequent litters as well

When the investigations in progress are completed, full details will be published

This communication is published by permission of of Dr. V R. Khanolkar, director, Indian Cancer Research Centre, under whose guidance the work is being done

B. K BATRA

Indian Cancer Research Centre,
Bombay
Nov. 2.

Table 1

Strain of mice	No of breeders	No of litters	No of young	Total No of young alive	Total No of young dead	Still-born young	Young with generalized hæmorrhage	Young with localized hæmorrhage	Young with blood clots
A (Strong)	4	11	62	40*	12	—	4	2	6
C_3H (Bar)	3	3	19	4	15	—	11	4	—
C_{57} (black)	4	8	40	3	37	5†	2	24	6

* One of these had a club foot
† All five belonged to the same litter The mother developed a uterine tumour

Morphine Antagonists

IN an earlier communication[1], we described the antagonistic action of tetrahydroaminacrin and 2-4 diamino 5 phenyl thiazole towards the depressant effects of morphine It was shown there that these antagonists did not affect the analgesic properties of morphine on rats

Since then we have had an opportunity of confirming this remarkable differential antagonism on human beings. Five patients suffering intolerable pain in the terminal stages of carcinoma were the subjects of this investigation. They had been receiving incomplete relief from up to 3 gr of morphine per day, given in divided doses at 2–4 hourly intervals. These patients were given as much as 1½ gr of morphine in one injection, and the severe respiratory depression and narcosis which followed were relieved by an injection of up to 40 mgm of 2-4 diamino 5 phenyl thiazole The analgesic effect of the morphine was, however, unaffected, and the patients remained free from pain for twelve hours and longer

The relief from the depressant effects of morphine was selectively graded. Respiratory depression was first relieved, followed by a lessening of the narcosis, as the dose of 2-4 diamino 5 phenyl thiazole was increased, large doses completely awakened the patient without lessening the analgesia, although the duration of relief was shortened

We have been able to observe the above response daily in two cases for a period of ten weeks and in a further two cases for a period of six weeks. During this period there was no evidence of the development of any tolerance, either to morphine or 2-4 diamino 5 phenyl thiazole

The thiazole derivative differed from N-allyl-*nor*-morphine in several respects. It did not provoke withdrawal symptoms in patients already receiving morphine and therefore is not a complete antagonist[2] It had no disagreeable side-effects when given alone in doses five to ten times the therapeutic, but individual variation should always be anticipated It does not antagonize the analgesic action of the morphine in therapeutic doses

Both compounds are antagonists of 'Pethidine', 'Amidone' and 'Omnipon'. The full results will be published in a clinical journal[3]

F. H Shaw
A. Shulman

Departments of Pharmacology and Physiology,
University of Melbourne.
Nov. 1.

---

[1] Shaw, F H , and Bentley, G , *Nature*, 169, 712 (1952)

[2] Winter, C A *et al*, *J Pharm and Exp Ther*, 111, 152 (1954)

[3] Shulman, A , and Shaw, F H , *Brit Med J* (in the press)

Size of the Myosin Molecule

At present considerable confusion exists concerning the size of the myosin molecule In a recent paper, Parrish and Mommaerts[1] reported a molecular weight of 650,000 and sedimentation-diffusion data which differ considerably from previous ones reported by various authors.

We would like to report briefly our findings, which set the molecular weight of myosin even lower than those of Parrish and Mommaerts. Using fresh myosin which had not been exposed to temperatures above 10° C. (see ref. 2), we find the diffusion coefficient $D_{20}^{w} = 1\ 0 \times 10^{-7}$ (measured at 1° C and extrapolated to zero concentration), in very good agreement with the value found by Parrish and Mommaerts[1], and considerably higher than those obtained by earlier workers. The sedimentation constant extrapolated to zero concentration and measured at approximately 4° C gives $S_{20}^{w} = 6\ 15 \times 10^{-13}$ (ref 3) This figure is in agreement with 6 20 obtained also at low temperature by Miller *et al*[4] Using a value of 0 728 for the partial specific volume[1], the molecular weight is calculated to be about 500,000

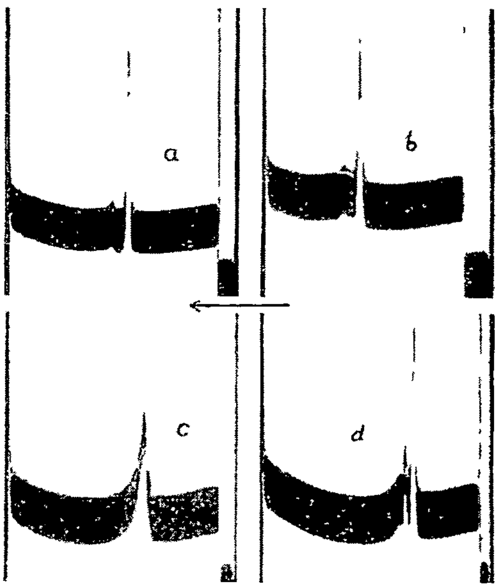


Fig 1 0 42 per cent myosin in 0 6 *M* potassium chloride, 0 005 *M* histidine buffer, *p*H 6 8, centrifuged at 59,780 r p m under different conditions (*a*) fresh myosin at 5 1° C , 129 min , *S*(*w*, 20) = 4 6 , (*b*) fresh myosin at 26 0° C , 81 min , *S*(*w*, 20) = 5 1 , (*c*) myosin incubated 2 hr at 25° C run at 28 7° C , 49 min , *S*(*w*, 20) = 8 2 , (*d*) myosin incubated 2 hr at 25° C , run at 9 0° C , 81 min , *S*(*w*, 20) = 4 8 The arrow shows the direction of sedimentation

In addition to confirming the observations of Mommaerts[1] and Blum and Morales[5] that the apparent sedimentation constant of myosin depends somewhat on temperature (see some of our results in Table 1), we found that more profound changes occur in the myosin molecule when left standing at temperatures of 25–30° C for several hours Fresh myosin centrifuged at 5° or 25° C shows a typical sharp sedimenting boundary with a sedimentation constant of about 5×10^{-13} (Fig. 1, *a* and *b*). If left standing at room temperature for two hours, the nature of the boundary changes and the sedimentation constant increases to $8\ 2 \times 10^{-13}$ (Fig 1, *c*). At this stage, however, the change is apparently reversible, for when centrifuged in the cold the more symmetrical sharp boundary reappears and $S = 4\ 8 \times 10^{-13}$ (Fig 1, *d*) Longer incubation apparently produces further and irreversible changes These changes in the hydrodynamic properties of myosin with temperature may be peculiar to myosin and related to its role as the contractile protein of muscle, but in any event they seem to be the explanation of the divergent values reported in the literature. Whether the change with increased temperature represents a change of shape or aggregation or both cannot yet be stated

Table 1 EFFECT OF TEMPERATURE ON APPARENT SEDIMENTATION CONSTANT OF MYOSIN

0 19 per cent myosin in 0 6 *M* potassium chloride

Temperature of run (av) (in ° C)	$S(w, 20) \times 10^{13}$
5 5	5 1
11 0	5 3
25 6	5 5

Since the changes can be expected to occur slowly even at low temperature, one suspects that the actual diffusion coefficient is probably higher than that we obtained, and, therefore, the figure of 500,000 may be considered too high.

Nevertheless, the molecular weight of myosin can be considered as established from the size determinations performed on the meromyosins—the split products of myosin. The meromyosins appear to be more stable than myosin and readily amenable to sedimentation and diffusion studies. Since we found that the amino-acid compositions of the meromyosins add up to myosin[6], the sum of the molecular weights of the meromyosins (two L- and one H-meromyosin) should give the molecular weight of myosin.

The diffusion coefficients and the sedimentation constants of the meromyosins have been carefully determined by A. G. Szent-Gyorgyi[7]. With these results and an assumed value of 0.748 for the specific volumes, the molecular weights of 96,000 (for L-meromyosin) and 232,000 (for H-meromyosin) were obtained. Gergely *et al.*[8] have published recently molecular weights of the same order of magnitude for the meromyosins obtained by chymotryptic digestion. The sum of the meromyosins (two L and one H) gives a molecular weight of 424,000 for myosin. This figure is about half that obtained by Weber and one-fourth of that obtained by Snellman. It is possible that the previous investigators were measuring the molecular weight of some stable step-wise aggregate of myosin probably isolated as such from the muscle tissue.

K. LAKI
W. R. CARROLL

National Institute of Arthritis
and Metabolic Diseases,
National Institutes of Health,
Public Health Service,
Department of Health,
Education and Welfare,
Bethesda, Maryland.
Nov. 3.

---

[1] Parrish, R. G., and Mommaerts, W. F. H. M., *J. Biol. Chem.*, **209**, 901 (1954).

[2] Kessler, V., and Spicer, S. S., *Biochim. et Biophys. Acta*, **8**, 474 (1952).

[3] Laki, K., Spicer, S. S., and Carroll, W. R., *Nature*, **169**, 328 (1952).

[4] Miller, G. L., Golden, R. H., Eibelman, E. S., and Miller, E. E., *Arch. Biochem. and Biophys.*, **41**, 125 (1952).

[5] Blum, J. J., and Morales, M. F., *Arch. Biochem. and Biophys.*, **43**, 208 (1953).

[6] Kominz, D. R., Hough, A., Symonds, P., and Laki, K., *Arch. Biochem. and Biophys.*, **50**, 148 (1954).

[7] Szent-Gyorgyi, A. G., *Arch. Biochem. and Biophys.*, **42**, 305 (1953).

[8] Gergely, J., Gouvea, M. A., and Karibian, D., *J. Biol. Chem.*, [**212**, 165 (1955).]

Visual Pigments and Vitamins A of the Clawed Toad, *Xenopus laevis*

DARTNALL[1] has recently reported extracting what he describes as a new visual pigment from the retina of the South African clawed toad, *Xenopus laevis*. It is a purple substance, which in Dartnall's preparations has an absorption maximum (λ_{max}) at 514–516 mμ. Its difference spectrum—the difference in absorption between it and the products of its bleaching—has λ_{max} 521 mμ at *p*H about 8.6. Dartnall argues, largely on the basis of analogies with the behaviour of other types of preparation, that the absorption maximum of the *Xenopus* pigment in reality lies at 519 mμ. I see no reason, however, for rejecting his measurements, which are as stated. They show the properties of the *Xenopus* pigment to be intermediate between those of rhodopsin and porphyropsin. The absorption spectrum of rhodopsin ordinarily has λ_{max} 500 ± 2 mμ, that of porphyropsin λ_{max} 522 ± 2 mμ[2]. The *Xenopus* pigment, with λ_{max} about 515 mμ, might on this basis consist of a mixture of about 70 per cent porphyropsin and 30 per cent rhodopsin. Its difference spectrum is similarly intermediate. λ_{max} of rhodopsin lies at about 500–502 mμ, that of porphyropsin at about 525–530 mμ in such mildly alkaline solutions as Dartnall employed; so that again the *Xenopus* pigment, with difference λ_{max} 521 mμ, appears to be a mixture of about two-thirds to four-fifths porphyropsin with one-third to one-fifth rhodopsin.

Such a mixture of pigments should be most easily analysed through the fact that, in retinæ exposed to light, rhodopsin bleaches to yield vitamin A_1, porphyropsin to yield vitamin A_2. The vitamins A are readily identified by the blue products which they form on mixing with antimony chloride reagent, possessing characteristic absorption bands, vitamin A_1 at about 620 mμ, vitamin A_2 at about 690 mμ.

Fig. 1 shows the absorption spectra of antimony chloride tests with extracts of *Xenopus* retinæ, pigment layers (pigment epithelia + choroids), and livers. Twelve male animals which had been kept without food for three weeks were dark-adapted, and the eyes removed under red light. The retinæ were separated from the pigment layers, and were bleached by exposure to moderate light for 1.5 hr. This treatment degrades the visual systems to the vitamins A. The retinæ and pigment layers were digested separately in 6 per cent potassium hydroxide in methanol. This mixture was diluted with water and extracted thoroughly with petroleum ether. The extracts, transferred to chloroform, were mixed with saturated antimony chloride in chloroform, in absorption cells already placed in a Cary recording spectrophotometer, and the absorption spectra of the resulting products were recorded immediately. These are shown in Fig. 1.

Livers from six toads were minced, ground with anhydrous sodium sulphate until powdery, and extracted with petroleum ether. The yellow extract was saponified in 6 per cent potassium hydroxide in methanol, and transferred to hexane. It contained a yellow carotenoid, epiphasic in partition between petroleum ether and 90 per cent methanol, and possessing absorption bands in hexane at 447.5 and 475 mμ. In these properties it resembles α-carotene (λ_{max} 447.5, 478 mμ). The liver extract also contained a mixture of vitamins A. It possessed an absorption band in the near ultra-violet at 333 mμ in chloroform (vitamin A_1, 328 mμ; A_2, 350 mμ), and yielded with antimony chloride the spectrum shown in Fig. 1, displaying the bands near 620 and 690 mμ characteristic of both vitamins.

Fig. 1 shows that the bleached *Xenopus* retina contains predominantly vitamin A_2. The same is true of the pigment layers. A broad elevation of spectrum in the region of 620 mμ in both cases represents a small admixture of vitamin A_1. The livers also contain both vitamins A, but in reverse proportions, vitamin A_1 predominating.

The proportions of vitamins A_1 and A_2 in such mixtures are readily assessed by solving the simultaneous equations

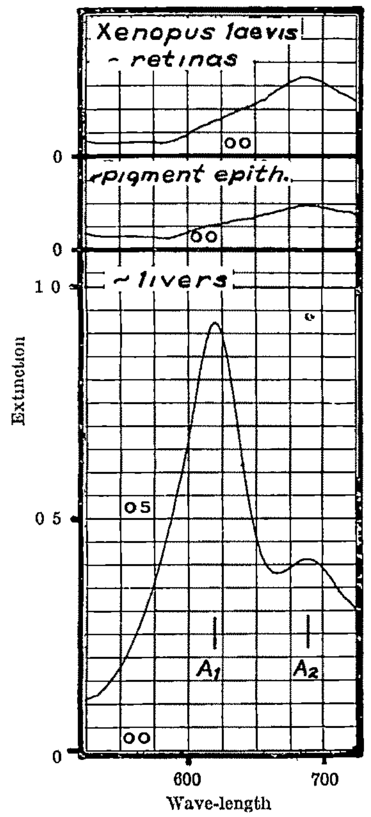


Fig 1 Absorption spectra of antimony chloride tests with saponified extracts of eye tissues and livers of the clawed toad, *Xenopus laevis* The spectra were recorded automatically, immediately after mixing the reagents An absorption maximum at about 620 mμ identifies vitamin A_1, one at about 690 mμ vitamin A_2 The spectra show that the bleached retina and the pigment layers—pigment epithelium and choroid—contain vitamin A_2 mixed with a little A_1, whereas the livers contain predominantly vitamin A_1

$$x = \frac{2\ 56\ k_{620} - k_{690}}{2\ 48};\quad y = k_{690} - 0\ 08\,x,$$

in which k_{620} and k_{690} are the extinctions measured at these wave-lengths, x is the extinction at 620 mμ specifically due to vitamin A_1, and y the extinction at 690 mμ specifically due to vitamin A_2 [3]. x and y can be converted into μgm /ml in the test solution by dividing x by 0 44 and y by 0 41 (since E (1 per cent, 1 cm) in the antimony chloride test is 4400 for vitamin A_1, and 4100 for A_2 [4]) In this way we find the proportions of the vitamins A in *Xenopus* tissues to be approximately as follows retinæ, $A_1/A_2 = 5/95$, pigment layers, $A_1/A_2 = 12/88$, livers, $A_1/A_2 = 68/32$ About 0 06 μgm of vitamin A_2 was obtained from each *Xenopus* retina, and about half as much from the pigment layers of each eye.

We may conclude that the principal visual pigment of the *Xenopus* retina is porphyropsin In our animals —judging from the amount of vitamin A_1 present—this seems to have been accompanied by a very small proportion of rhodopsin Dartnall's extracts, interpreted in these terms, appear to have contained a higher proportion of rhodopsin, owing possibly to his having fed his animals with raw liver, a material notoriously rich in vitamin A_1 The possibility must also be conceded, though a little unlikely, that λ_{max} for *Xenopus* porphyropsin lies at shorter wave-lengths than that for other porphyropsins so far investigated Even if it lay at the short wave-length limit for known porphyropsins, little discrepancy would remain between the proportions of rhodopsin and porphyropsin estimated on the basis of Dartnall's measurements and our own It should be added that if Dartnall is correct in his belief that the true λ_{max} of the *Xenopus* pigment lies at 519 mμ, no discrepancy at all remains between his measurements and ours

Dartnall tested his extracts for the presence of a mixture of pigments, by inquiring whether partial bleaching in various regions of the spectrum would produce differential effects He concluded that he had to deal with a single pigment To this it must be said, however, that he had over-estimated the differences to be expected, in the belief that the λ_{max} of porphyropsin is near 533 mμ, a belief based upon indirect considerations[5]. All direct measurements made so far upon adequate preparations of porphyropsin give λ_{max} at 522 ± 2 mμ (cf ref 6). The absorption spectra of rhodopsin and porphyropsin therefore overlap very widely, and only the most searching measurements would resolve such mixtures as here indicated It is possible that slight bleaching in red light as compared with white light would reveal a difference, unfortunately Dartnall, though he apparently made such measurements, has not shown the results in a form that permits accurate discrimination.

Xenopus is not the only animal that presents such a mixture of visual pigments and vitamins A in the eye and liver as we have described The anadromous sea lamprey, *Petromyzon*[7], and the anadromous chinook salmon and brook trout[3,8] present much the same pattern. I have found this distribution also among tailed Amphibia in the permanently larval mudpuppy, *Necturus*[9], and among tailless Amphibia in the tadpole of the bullfrog, *Rana catesbiana*, in which the distribution of visual pigments and vitamins A is almost identical with that in *Xenopus*[9].

Porphyropsin is associated characteristically with vertebrates which dwell in, or more specifically which originate in, fresh water. It is this association which we pursue through the anadromous lamprey, the freshwater fishes, the adult water-phase newt, and the larval amphibia already cited[9] The special significance, therefore, of Dartnall's observation is not the discovery of a new visual pigment, but the first demonstration of porphyropsin in an adult anuran It is particularly significant that this should involve *Xenopus*, a member of the peculiar group *Aglossa*, possessing neither tongue nor teeth, and a purely aquatic animal. Here, as in other examples, the genetic factors which govern the freshwater habit have brought the use of porphyropsin in their train

(This research was supported in part by funds from the Rockefeller Foundation and the Office of Naval Research)

GEORGE WALD

Biological Laboratories,
Harvard University,
Cambridge, Mass Oct 16.

[1] Dartnall, H J A , *J Physiol*, **125**, 25 (1954)
[2] Wald, G , *J Gen. Physiol*, **21**, 795 (1937-38), **22**, 775 (1938-39)
[3] Wald, G , *J Gen Physiol*, **22**, 391 (1938-39)
[4] Cawley, J D , Robeson, C D , Weisler, L , Shantz, E M , Embree, N D , and Baxter, J G , *Science*, **107**, 346 (1948) Shantz, E M , *Science*, **108**, 417 (1948)
[5] Dartnall, H J A , *J Physiol*, **116**, 257 (1952)
[6] Wald, G , *Ann Rev Biochem*, **22**, 497 (1953)
[7] Wald, G , *J Gen Physiol*, **25**, 331 (1941-42)
[8] Wald, G , *J Gen Physiol*, **25**, 235 (1941-42)
[9] Wald, G , Harvey Lectures, **41**, 117 (1945-46), "Biochemical Evolution", in "Modern Trends in Physiology and Biochemistry", 337 (E S G Barron, editor) (Academic Press New York, 1952)

A New Structure observed in *Trypanosoma evansi* (Indian Strain)

Recent investigations show the existence of a new structure in the Indian strain of *Trypanosoma evansi*, the causal agent of the virulent disease 'surra' in domestic and other animals

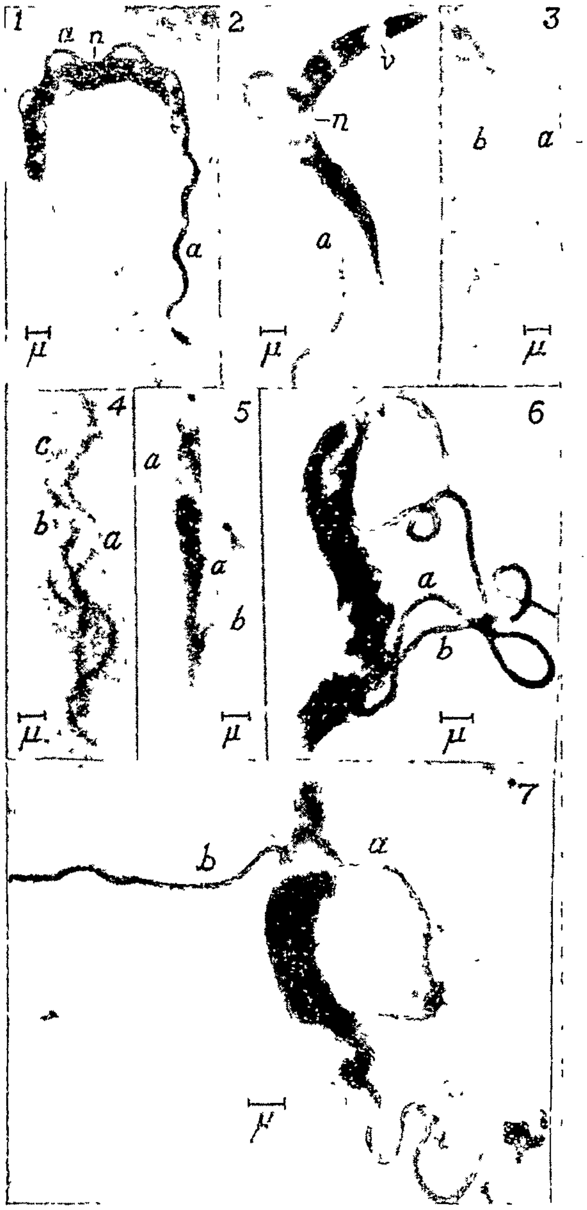
Trypanosoma evansi was maintained *in vivo* in white rats and transferred every few days whenever the infection was too heavy in one animal. These specimens after suitable treatment were studied with the light, phase-contrast and electron microscopes Stained films for photomicrography were made by making a smear of infected blood on a glass slide and staining with J S B [1] stain (Fig. 1). For phase-contrast microscopy, a drop of infected blood was mixed with physiological saline on a glass slide, a cover glass was superposed and pressed in order to produce a very thin film of suspension When the movement of the flagellates ceased, phase-contrast micrographs were made with a Spencer dark *M* phase objective (Fig. 2)

Trypanosomes are known to be uniflagellate organisms In the stained photomicrograph (Fig 1), the major part of the flagellum (*a*) is found to form the bordering filament of the undulating membrane, and only a small portion of this structure extends beyond the body as free flagellum This flagellum (*a*) is also clearly visible in the phase-contrast micrograph of the unstained parasites (Fig 2) In the latter the nuclear site (*n*) is seen to be lighter than the rest of the cell, with the exception of the vacuole (*v*) This shows that the nuclear site has a smaller optical path compared to the rest of the cell, a fact which has also been noticed in the case of *Leishmania donovani*[2]

For further detailed study, the trypanosomes were separated and concentrated from infected blood by centrifugation with normal saline The concentrated specimens were then treated in the following three methods. In the first method, a portion of the concentrate was suspended in distilled water for 30 min. at room temperature This water-treated material was then fixed in Schaudin's fluid, stained with Heidenhain's iron hæmatoxylin (long method) and then micrographed (Figs. 3, 4). A second part of the concentrate was crushed between two glass slides by the application of pressure and afterwards stained with J S B stain (Fig 5)

In Figs 3 and 4 showing specimens treated with distilled water, the whole of the protoplasmic material has disintegrated and a two-flagella structure is clearly visible (Fig 3, *a* and *b*) One of the flagella observed (*a*) is the usual flagellum which originates from the blepharoplast and is attached to the body surface (cf Figs 1 and 2) The second flagellum (*b*) is also found to originate from the region of the blepharoplast This possibly forms the inner border of the undulating membrane and is usually missed in the stained photomicrographs. This second structure (*b*) will be referred to as 'costa' in analogy with a similar organelle found at the base of the undulating membrane of trichomonad flagellates When the organism is in the dividing stage (Fig 4), in addition to the two flagella (*a* and *b*) already described a third one (*c*) is also noticeable. In the photomicrograph obtained from crushed and stained specimens (Fig 5) the two flagella (*a* and *b*) are again seen

A third part of the concentrated specimen was fixed in 1 per cent formalin for examination with the electron microscope The organisms were so dense, however, that no internal structure was visible In order to make the specimens more transparent to the electron beam, they were subjected to hydrolysis in N hydrochloric acid at 60° C, a treatment which has proved very suitable for the study of other protozoal organisms, namely, *Leishmania donovani*[2], and *Plasmodium burghei*[3]



Micrographs of *Trypanosoma evansi* under different conditions (*n*) Nucleus, (*v*) vacuole, (*a*) flagellum usually observed and (*b*) the second flagellum

Fig 1 Photomicrograph after J S B stain Fig 2 Dark phase-contrast micrograph of a living specimen showing that the nuclear site is lighter than the rest of the cell Fig 3 Specimen treated with distilled water, showing the common origin of the two flagella Fig 4 Specimen treated with distilled water in a dividing stage, in addition to the two flagella (*a*) and (*b*) a third one (*c*) is also noticeable Fig 5 A crushed specimen Figs 6 and 7 Electron micrographs Notice two flagella (*a*) and (*b*) originating from the same place and uneven electron scattering power in different parts of the cell

The electron micrographs of the hydrolysed specimens (Figs 6 and 7) again show the existence of the two flagella (*a* and *b*) Both flagella are found to originate from the same place, the longer one (*a*) forming the bordering flagellum of the undulating membrane is still intact in some parts in both figures. Close observation of Fig. 6 reveals the presence of fine fibrils attached to the surface of the two flagella. This is highly suggestive of the fraying of the protoplasmic sheath in the process of hydrolysis. However, during this work, the presence of fine fibrils composing the flagellum was not observed, as reported by Kraneveld *et al.*[4]

Thus the photomicrographs of water-treated and crushed specimens, as well as the electron micrographs of the hydrolysed specimens, definitely show that *Trypanosoma evansi* (Indian strain) possesses a structure at the inner border of the undulating membrane which can very well be compared with the 'costa' or basal fibre of the flagellates belonging to the family Trichomonadidae.

H. N. RAY
School of Tropical Medicine,
Calcutta 12.

N. N. DAS GUPTA
M. L. DE
A. GUHA
Biophysics Division,
Institute of Nuclear Physics,
Calcutta 9.
Oct. 23.

---

[1] Singh, J., and Bhattacharya, L. M., *Ind. Med. Gaz.*, 79, 102 (1944).

[2] Das Gupta, N. N., Guha, A., and De, M. L., *Exp. Cell Res.*, 6, 353 (1954).

[3] Dutta, B. N., Das Gupta, N. N., De, M. L., Guha, A., and Nandi, S., *Science*, 120, 428 (1954).

[4] Kraneveld, F. G., Hauwink, A. L., and Keidel, H. J. W., *Proc. Kon. Ned. Akad. Wetensch.*, C, 54, 393 (1951).

Life-cycle of *Porphyra capensis* Kutz.

ALTHOUGH germination of the spores of *Porphyra* has been observed under cultural conditions by a number of workers[1,2], the complete life-cycle of this plant, from the germination of the carpospore to the re-establishment of the leafy thallus, has never been conclusively demonstrated. The most recent work has been done with *P. umbilicalis* (L.) Kutz. by Drew[1,3], who has shown that the filaments produced by the carpospores of this species will penetrate shell and afterwards form growths which appear to be identical with those of *Conchocelis rosea* Batters[4]. Sporangia-like bodies (termed 'fertile cell rows' by Drew) developed in the cultures, but no spores were formed from these. Evidence of spore formation was obtained, however, from some similar growths occurring naturally in the scales of the barnacle *Pollicipes cornucopia* Leach[5].

No previous investigations have been carried out on the life-history of the South African species *Porphyra capensis* Kutz. In 1952, therefore, an attempt was made to germinate the carpospores of this species in culture. The spores were placed on glass slides and on pieces of egg shell, and in both cases growths were obtained which were similar to those recorded by Drew for *P. umbilicalis*[3]. Filaments from the spores placed on egg shell penetrated the shell and formed much-branched extensive growths, but the plants did not develop further. There was no convincing evidence of the formation of any bodies of a reproductive nature.

In February 1954, a further attempt was made. Development of filamentous growths from carpospores and their penetration of the shells proceeded as before, but this time a large number of sporangial structures were produced which closely resembled those described by Drew as 'fertile cell rows' (Fig. 1, *a*, *b*).

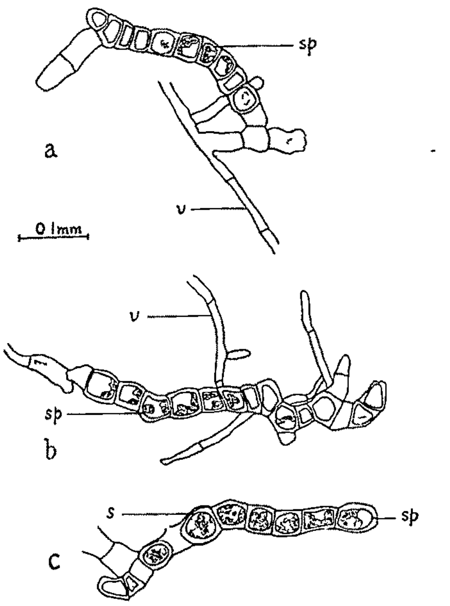


Fig. 1. Parts of plants of filamentous phase of *Porphyra capensis* Kutz. from the surface of egg shell 41 days after first emersion of the shell. Culture eight months old. (*a*) and (*b*), branched rows of sporangia (*sp*) and vegetative branches (*v*); (*c*) early stage in spore formation (*s*).

The cultures were maintained, and at the beginning of August a number of young leafy plants of the adult phase of *Porphyra* were seen to be growing attached to the bottom of the glass flask in which the shells were kept. Considerable care had been taken to keep these cultures free, so far as possible, from outside infection. The shells and apparatus employed were sterilized and only boiled, filtered sea-water was used. The cultures were aerated with air passed through a cotton-wool filter. The shells were periodically exposed to the air for periods of about an hour, so that to this extent the cultures were not under sterile conditions. However, it should be noted that leafy plants developed in the flask and not on the shells. Therefore, although the evidence was not conclusive, it would seem reasonably certain, in view of the precautions taken, that the young leafy plants had arisen from the filamentous plants growing in the same culture. Recently, in a second similar culture, germinating spores were observed in some of the sporangia, each sporangium producing one spore (Fig. 1 *c*). Other spores were observed to germinate after liberation from sporangia (Fig. 2).

Young leafy plants were produced, some of which were within, and others outside, the sporangia (Fig. 3). The leafy plants previously observed to be attached to the bottom of the flask were at a more

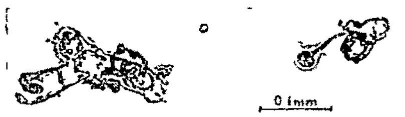


Fig. 2. Germinating spore of leafy phase of *Porphyra capensis* Kutz. Sporangia of filamentous phase can also be seen. Photographed in the living condition.

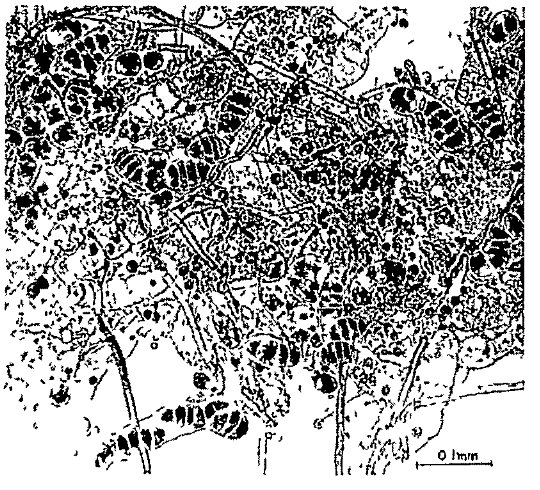


Fig 3 Parts of plants of filamentous phase of *Porphyra capensis* Kutz from the surface of egg shell, showing rows of sporangia and vegetative branches with spores and young plants of the leafy phase Photographed in the living condition

advanced stage of development than those shown in Fig. 3.

The exact mode of liberation of the spores is uncertain, although in some cases there is breakdown of the transverse walls between individual sporangia as described by Drew for the material from *Pollicipes cornucopia*[5].

A full account of this work is to be published later Thanks are due to the South African Council for Scientific and Industrial Research, the financial support of which has made possible the continuance of this investigation, and to Prof Wm. Edwyn Isaac for general guidance of the research

JUDITH M GRAVES

Department of Botany,
University of Cape Town
Oct 25.

[1] Drew, K M, *Nature*, **164**, 748 (1949)

[2] Grubb, V M, *Rev Algol*, **1**, 223 (1924)

[3] Drew, K M, *Ann Bot*, N S, **18**, 183 (1954)

[4] Batters, E A L, *Phycol Mem*, **1**, 25 (1892)

[5] Drew, K M, and Richards, K S, *J Linn Soc*, **55**, 84 (1953)

Positional Pseudo-Alleles in Diploid Potatoes

THE anthocyanins of diploid cultivated potatoes ($2n = 24$) are controlled by at least two independent loci of which one, P, is epistatic to the other R[1] Three closely linked loci, B, I and F, on another chromosome, are concerned with the distribution of pigment on the body of the plant. Locus I in its homozygous recessive phase ii is epistatic to the two colour loci and leads to the absence of pigment in the tuber, to which organ its main action is localized. Locus F governs the contrast between flecked and self-coloured flowers The former are homozygous recessives, ff, they are mainly white, but show dashes of colour on and around the vascular 'star' which is characteristic of the corolla Loci I and F have shown a recombination value of 1 98 ± 0 62 per cent

Seeds may be spotted owing to the presence of pigment on the cotyledonary node of the embryo and which shows through the testa On the haulm, opposite the axil of each leaf, there may be a nodal band of pigment on the abaxial surface. The floral abscission layer may be coloured with anthocyanin or green. In white tubers, the eyebrow may be coloured or uncoloured, but the difference is masked in self-coloured tubers Apparently these manifold expressions of the distribution of pigment may occur separately or together in nearly all combinations They are on homologous parts of the plant body and seem to be interpreted most satisfactorily by assuming a series of alleles, $B^d > B^c > B^b > B^a > b$, in order of dominance No estimate is given of the close linkage between loci B and I because satisfactory parents for the appropriate crosses are not yet available

Table 1 PHENOTYPIC EFFECTS OF ALLELES AT LOCUS B

Allele	Pigment			
	Spot on embryo	Nodal band	Floral abscission	Tuber eyebrow
b	−	−	−	−
B^a	−	−	+	−
B^b	−	−	+	+
B^c	+	−	+	+
B^d	+	+	+	+

$C\,P\,C$ 827[2] $\frac{B^c i F}{b\,I F}$ was crossed with $C\,P.C.$ 1776 $\frac{b i f}{b i f}$ and the expected two classes $\frac{B^c i F}{b i f}$ and $\frac{b I f}{b i f}$ were obtained In addition, two recombinants occurred. (*a*) $\frac{B^c i f}{b i f}$ and (*b*) $\frac{B^c I f}{b i f}$.

One of these, namely (*a*), a plant with white tubers and red eyebrows and flecked flowers, raised from a non-spotted seed, must have resulted from a crossover between loci I and F which, as mentioned above, have 1 68 ± 0 62 per cent recombination That this individual is heterozygous $B^c b$ may be inferred from the presence of a coloured eyebrow on the tuber.

The other recombinant, namely (*b*), is a plant with blue tubers and flecked flowers raised from a spotted seed That it is indeed heterozygous $B^c b$ and not a misclassified non-spot is shown by its breeding behaviour in a backcross to $C\,P\,C$ 1776 Expectation is a 1 3 ratio of spotted to non-spotted seeds, because the spotting effect of locus B is expressed only in the presence of allele P, for which $C\,P\,C$ 1766 is homozygous recessive. Out of 255 seeds, 60 had purple spots and 195 were without spots (χ^2 to a 1 3 ratio is 0 29 for 1 d f., $P = 0\ 60$).

The occurrence of recombinant (*b*) shows that the three loci are arranged in the chromosome in the sequence B—I—F

A notable feature of the recombinant $\frac{B^c I f}{b i f}$ is that nodal bands of pigment occur on the haulm opposite the axils of all leaves Thus it appears that when allele B^c is brought into contiguity with dominant allele I, the characteristic banding effect of allele B^d is developed (Table 1) Allele B^d occurs in only one clone of our collection, namely, $C\,P\,C.$ 2211, of which the genotype is $B^d I F$ Here also alleles B^d and dominant I are adjacent, and until they are separated by recombination it cannot be decided whether B^d is merely the compound $B^c I$ or an allele in its own right

This example is similar to those interactions in *Drosophila*[3] in which the heterozygotes represented as $+_1+_2/m_1m_2$ and $+_1m_2/m_1+_2$ (*m* designates the mutant form) are not equivalent in action. Like the A^b locus[4] in maize, physically distinct units function co-operatively in the determination of an effect.

The observation is of particular interest owing to the implication that the proximity of these loci concerned with distribution of pigment is not fortuitous.

A fuller account of this work will be published elsewhere with my colleague D. H. Long, who recorded this progeny at the Agricultural Research Council's Potato Genetics Research Station in Cambridge.

KENNETH S. DODDS

John Innes Horticultural Institution,
Bayfordbury,
Hertford, Herts.
Nov. 2.

---

[1] Dodds, K S , and Long, D H , *J Genet* (in the press)

[2] Hawkes, J G , *I A B Bull* , pp 142 (1944)

[3] Lewis, E B , *Genetics*, 33, 113 (1948) Green, M M , and Green, K C , *Proc U S Nat Acad Sci* , 35, 586 (1949)

[4] Laughnan, J R , *Proc U S Nat Acad Sci* , 35, 167 (1949)

Hereditary (Seed-borne) Symbiosis in *Ardisia humilis* Vahl.

STEVENSON[1] recorded bacterial symbiosis in some New Zealand plants, Singh[2] noticed bacteria in stems, leaves and flowers of a number of angiospermic plants in South India, and Heimbeck[3] recently reported the occurrence of *L* forms of bacteria in wilting pea, which are filtrable through membranes that retain the smallest bacteria.

In *Ardisia humilis* (Myrsinaceae) growing in the Carmichael Medical College garden, schizogenous glands are found in leaves, stems, roots, floral envelopes (calyx and corolla), stamens, styles and in endosperms of seeds *B*. type *L* forms of bacteria are found in large numbers close to these glands, and a pinkish colour is very noticeable in young leaves (especially at their margins), sepals, petals, anthers, carpels and seeds Roots have conspicuous irregular nodular swellings due to infection by bacteria, and leaves, sepals and petals bear a large number of glands. The plants are perfectly healthy, they have grown for more than twenty years in the College garden and normally bear abundant lilac-coloured flowers and fruits. In fact, *B* type *L* forms of bacteria are found in every part of the plant, especially in growing regions and organs Bacteria were aseptically isolated from leaves and roots and were grown in pure culture in nutrient agar, malt-agar and in liquid malt, when a large number of *L* bodies similar to those photographed by Heimbeck (Fig Nos 7–11)[3] were found along with the bacteria in the form of small granules. The *L* forms were found to grow in small colonies without exuding mucilage or slime, their colonies forming each a dark central portion surrounded by lighter peripheral zone. Such forms are regarded by Klemeberger-Nobel[4] as forms intermediate between virus and bacteria.

Pohjakallio *et al* [5] remark that micro-organisms (in their case, one *Pseudomonas* sp) may antibiotically limit the damage caused by clover-rot fungus (*Sclerotinia trifoliorum* Erikss) to clover, *Trifolium pratense.*

The red colour from leaves, roots, anthers, etc , can be extracted easily with absolute alcohol. Absorption spectra of this colour and its chemical characters are being studied with the view of finding out if it contains hæmin and also if this colour is the metabolic product of *L* type organisms. The results of this study will be described in due course.

S. R. BOSE

Botanical Laboratory,
Carmichael Medical College,
Calcutta.
Oct. 26.

---

[1] Stevenson, G B , *Ann Bot* , N S , 17, 343 (1953)

[2] Singh, T C N , Ind Sci Congress Proc , Lucknow (1953), also Ind Sci Congress Proc (1950 and 1951)

[3] Heimbeck, L S , "On the Etiology of Brown Roots, Yellowing and Wilt due to 'B type L Forms' of Bacteria, with special reference to Pea-Wilt" (Levanger, Norway, 1954)

[4] Kleineberger-Nobel, E , *Biol Rev* , 29, 154 (1954)

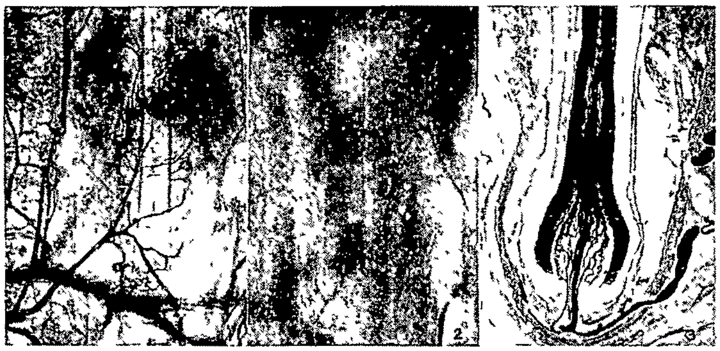
[5] Pohjakallio, O , Salonen, A , and Relander, E , *Acta Agric Scand* , 3, 53 (1953)

Blood Supply of Mystacial Vibrissæ

CURRENT interest in the blood supply to the skin and hair follicles of the sheep[1,2] prompts description of some recent investigations into the blood supply to the mystacial vibrissæ of the cat and rat. The animals were killed with ether and amyl nitrite, or intraperitoneal 'Nembutal', and a polythene cannula introduced into either the common carotid artery or jugular vein Blood was washed out with warm normal saline containing sodium nitrite or with 'Priscol', a sympathetic blocking agent. A warm 2 per cent aqueous solution of soluble Berlin-blue was the best of the injection masses used, due to its small particle-size and low viscosity. Techniques dependent on the presence of hæmoglobin did not reveal the fine vessels traversing the trabeculæ because they were obscured by blood in the sinuses, while constricted vessels empty of blood were overlooked

Observation on injected mystacial pads fixed either in 80 per cent alcohol and cleared by the method of Spalteholz, or in formal–saline and sectioned on the freezing microtome at 100–150 μ, show a main artery approaching the side of each follicle This gives branches to the striated muscles of adjacent follicles, and to a capillary plexus between the necks of the follicles, and then accompanies the sensory nerve passing through the outer dermal sheath at an angle of about 45° At the inner limit of the middle dermal sheath it divides into three branches (Fig. 1) The first, a fine vessel, turns sharply to the base of the follicle and contributes to a capillary network which extends to the hair matrix. A second, larger branch contributes to the capillary network of the middle region of the follicle, anastomosing with the first branch The third passing superficially gives rise to capillaries encircling the hyaline membrane reaching up to the deeper part of the ringwulst, from which region some of the injection mass could usually be seen escaping into the upper part of the cavernous sinus The injection mass never passed readily into the sinuses, which always contained blood even when an otherwise complete injection of the mystacial region had been accomplished

The efferent drainage of the follicle, the existence of which has not previously been reported, consists of a number of fine vessels (diameter *c* 4 μ) arising adjacent to the hyaline membrane and joining to form three principal vessels also of capillary dimensions (Fig 2). These unite and pass through the outer



(1) Artery supplying muscle, on left, before traversing outer dermal sheath into follicle, ringwulst and ring sinus above, main vein of region running deep, below Forward injection Rat, × 30

(2) Part of follicle showing fine efferent vessels Retrograde injection using 'Priscol' Rat, × 65

(3) Longitudinal section of base of follicle, afferent vessel to ascending papillary plexus on left, large efferent vessel on right Forward injection Frozen section Cat, × 30

dermal sheath in the deeper third of the follicle Immediately outside the sheath the efferent vessel enlarges (c 11 μ) and joins a vein into which the efferent vessel of the dermal papilla also drains.

The afferent vessel of the papilla derived from the arterial branch to the hair matrix is minute (c 5 μ), and gives rise to a network of capillaries covering the surface of the papilla, ascending to its apex in long twisting loops similar to those seen in dermal papillæ in other situations (Fig 3) The capillaries drain into a central efferent vessel of larger calibre (c 20 μ) which leaves the base of the follicle

The vascular pattern of the papilla is related, no doubt, to the high metabolic demand of an actively growing region In marked contrast, the relative dimensions of the afferent and efferent vessels to the sinus system suggest that blood is held in the sinuses under considerable pressure, providing a medium in which the hair and its root sheaths are suspended in a cradle of elastic strands, the trabeculæ This view is supported by experimental evidence which will be published at a later date.

M G. SCOTT

Battersea Polytechnic,
London, S.W.11.
Oct. 25.

[1] Ryder, M L, *Nature*, 172, 125 (1953)
[2] Ryder, M L, and Auber, L, *Nature*, **174**, 743 (1954)

Adult Behaviour-Pattern of *Anopheles gambiae* in Mauritius

SENIOR-WHITE[1] has suggested a most convenient system of classification for the adult behaviour of anopheline mosquitoes, especially the vectors of malaria. The classification is of considerable importance when assessing the vectorial capacity of *Anopheles gambiae*, which ought now to be regarded as a mosquito the behaviour of which is considerably plastic, it certainly is not "a vector wherever found" Under the environmental conditions of an oceanic island, such as Mauritius, *A gambiae* appears to lose its addiction for man It may be that when it first made its appearance in the island in the 1860's its full genetical complex was missing Again, there is a suggestion of a behaviour cline, *A gambiae* becoming less and less closely associated with man as its distribution recedes from the equatorial regions

Studies made since 1952 have shown that *A. gambiae* in Mauritius is strongly endophilic Only the unfed and unfertilized females are to be found resting out of doors. Male *A gambiae* are, however, strongly exophilic, and may be readily collected from rock crevices. Although it is so strongly endophilic, this is for cowsheds only It is most unusual to find resting individuals in houses Gebert[2] collected 46 from 12,561 houses, and Halcrow[3] found 6 unfed *A. gambiae* in 704 houses Precipitin tests have shown that the small number of the species that do feed on humans rest immediately afterwards in cowsheds It is suggested that Senior-White's classification of 'endophilic' should be subdivided into endophilic (houses) and endophilic (animal shelters), thus allowing for the unusual behaviour of the Mauritian *A gambiae*

Precipitin tests, based on 1,252 stomach smears of blood-fed *A. gambiae*, show a zoophilic index of more than 70 per cent, and an anthropophilic index of 2 8 per cent. Since 1,240 of the 1,252 smears were collected in cowsheds and from areas where herd cattle were absent and where the cattle were stalled in the cowsheds throughout the day and night, it would seem that a considerable degree of endophagy would be indicated Very few of the smears were negative for both cattle and man. As it is impossible to say whether the low number of blood-fed *A. gambiae* proved positive for humans obtained their blood meal in houses or in the open (the latter being more probable), a small degree of exophagism could be accorded to the species

The deviation of *A gambiae* into cowsheds might be explained by the great number of cowsheds in Mauritius. One-third of all buildings in Mauritius are cowsheds, in several villages within areas of prolific breeding of *A gambiae* the cowshed-to-house ratio is 1 1.

From observations made since 1952, it would seem that *A. gambiae* in Mauritius was, and is, a poor vector of malaria and bancroftian filariasis It is thought that the presence of *Anopheles funestus*, now eradicated, enhanced the low vectorial capacity of *A gambiae* by building up malaria to almost epidemic proportions In such an event *A. gambiae* would be more likely to become infected than at the present time, when the very low endemic malaria is dissipated by the deviation of this species to cattle

A summary of the adult behaviour pattern of *A. gambiae*, as it is found in Mauritius, is as follows almost completely endophilic (animal shelters), strongly endophagic and weakly exophagic This summary could be combined with other behaviour-pattern summaries from other geographical regions, and could form the basis for a study of a possible 'behaviour-cline' in *A. gambiae*.

Acknowledgment is made to the Colonial Insecticides Committee, which has financed this study.

JAMES G. HALCROW

Entomology Research Unit,
Richlieu, Mauritius.
Oct. 13

[1] Senior-White, R, *Nature*, 173, 730 (1954)
[2] Gebert, S., Report of Medical Dept, Mauritius (1952)
[3] Halcrow J. G (unpublished report 1953)

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, February 28

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 4 45 p m —Dr Joseph Needham, F R S "New Light on the Physico-Chemical Aspects of Morphogenesis" * (Further lectures on March 7 and 14)

UNIVERSITY OF LONDON (at King's College, Strand, London, W C 2), at 5 30 p m —Mrs Jean Floud "Education and Social Class in the Welfare State" * (Last of a series of lectures on "Looking Forward in Education")

INSTITUTION OF THE RUBBER INDUSTRY (at the Engineers' Club, Albert Square, Manchester), at 6 45 p m —Prof G Gee, F R S "Limitations of Rubbers"

Tuesday, March 1

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Prof S E Hollingworth "Geological Expedition to Northern Norway" *

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S W 1), at 5 30 p m.—Mr J P Stott "Prestressed Concrete Roads"

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W C 2), at 5 30 p m —Prof F Brailsford and Mr C G Bradshaw "Iron Losses at High Magnetic Flux Densities in Electrical Sheet Metals", Dr C D Mee and Dr R Street "An Improved Precision Permeameter"

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m —Dr C H Andrewes, F R S "The New Look in Virus Research" (Last of a series of lectures on "The Scientific Basis of Medicine")*

UNIVERSITY OF LONDON (at King's College, Strand, London, W C 2), at 5 30 p m —Prof Cyril Domb "Statistical Physics and its Problems" *

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Dr P Hermans "The Chemistry of the Polymerization of Caprolactam"

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W 1), at 7 p m —Prof J V Connolly "The Scientific Approach and Research in Aircraft Production"

Wednesday, March 2

ROYAL SOCIETY OF MEDICINE, HISTORY OF MEDICINE SECTION (at 1 Wimpole Street, London, W 1), at 5 15 p m —Dr Ff Roberts "The Effects of Epidemics on Population and Social Life"

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W C 2), at 5 30 p m —Scientific Papers

Thursday, March 3

UNIVERSITY OF LONDON (at the Royal Veterinary College, Royal College Street, London, N W 1), at 4 p m —Prof Nils Lagerlöf (Stockholm) "Some Infertility Factors in Domestic Animals" * (Further lecture on March 4)

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 4 30 p m.—Mr G Badami and Sir Alfred Egerton, F R S "The Determination of Burning Velocities of Slow Flames", Prof R G W Norrish, F R S, Mr G Porter and Mr B. A Thrush "Studies of the Explosive Combustion of Hydrocarbons by Kinetic Spectroscopy"

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 5 p m —Dr T B Reynoldson "Current Taxonomy of the Freshwater Triclads of the British Isles", Dr G S Carter "The Papyrus Swamps of Uganda the Nature of the Environment"

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W C 2), at 5 15 p m —Prof Max Gluckman "Anthropology in Central Africa"

UNIVERSITY OF LONDON (at King's College, Strand, London, W C 2), at 5 30 p m —Prof R M Titmuss "War and Social Policy" * (From a series of lectures on "War and Society")

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S W 1), at 6 30 p m —Dr T G Pearson "Physical and Chemical Processes Occurring in the Electrolytic Production of Aluminium"

UNIVERSITY OF LONDON (at Wye College, Wye, near Ashford, Kent), at 8 15 p m —Dr H J Frankena (Wageningen) "Full Utilization of Pasture" *

Friday, March 4

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 2 45 p m —Annual General Meeting Dr D W Kent-Jones—Address of the Retiring President

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department of Imperial College, Imperial Institute Road, London, S W 7), at 5 30 p m —Dr H Mol "Identification of Speech Sounds"

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP—NORTHERN BRANCH (in the Medical Library The University, Sheffield), at 7 30 p m —Sir Ernest Finch "Leonardo da Vinci"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 9 p m —Sir Frederic Bartlett, F R S "Thinking—an Experimental Approach"

Saturday, March 5

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S E 23), at 3 30 p m —Dr Glyn E Daniel "The Megalith Builders" *

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

SENIOR LECTURER (with high academic and research qualifications, and able to teach to special (honours) degree standard) IN ORGANIC CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S E 18 (March 4)

LECTURER IN PHYSICAL CHEMISTRY at Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton (March 5)

NON-MEDICAL BIOCHEMIST (Senior Grade)—The Secretary, General Hospital, Nottingham (March 5)

SENIOR LECTURER IN PHYSICS, a LECTURER IN PHYSICS, LECTURERS (3) IN MATHEMATICS, LECTURERS (2) IN GENERAL SCIENCE, and a LECTURER IN CHEMISTRY, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W C 1 (March 7)

CHEMICAL ENGINEER (with a first- or second-class honours degree or equivalent qualification in chemical engineering) at a Ministry of Supply Establishment in S W England, for work which is concerned with the development of chemical processes involving semi-technical research, design and operation of pilot units and basic research in chemical engineering operations—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting F 60/5A (March 12)

PROFESSOR (able to pass an examination in Irish) OF MATHEMATICS —The Secretary, University College, Cork, Ireland (March 14)

ASSISTANT LECTURER (preferably with special qualifications in algebra and/or geometry) IN MATHEMATICS—The Secretary, Westfield College (University of London), Hampstead, London, N W 3 (March 15)

ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar The University, Manchester 13 (March 16)

ASSISTANTS IN RESEARCH (3) (with an honours degree in an appropriate subject) in agricultural engineering, animal physiology and soil science—The Secretary, School of Agriculture, Downing Street, Cambridge (March 16)

SCIENTIFIC OFFICER (with a good honours degree in science) IN THE FORAGE CROPS SECTION, to engage in genetical, physiological and breeding research in grasses and legumes—The Secretary, Plant Breeding Institute, Trumpington, Cambridge (March 16)

LECTURER IN VERTEBRATE ZOOLOGY—The Registrar, King's College, Strand, London, W C 2 (March 18)

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (physicist or engineer) (with an honours degree in science or engineering, and preferably with industrial research experience) IN THE WOOL TEXTILE RESEARCH LABORATORIES, Geelong, Victoria, Australia, to carry out developmental work on wool textile machinery—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2 (March 19)

MONSANTO RESEARCH SCHOLAR (with a degree in science or engineering) IN CHEMICAL ENGINEERING—The Registrar, New South Wales University of Technology, Broadway, Sydney, N S W, Australia (March 21)

RESEARCH FELLOW IN ELECTRON PHYSICS—The Registrar, The University, Edgbaston, Birmingham (March 26)

LECTURER IN APPLIED MATHEMATICS at St Salvator's College, St Andrews—Joint Clerk to the University Court, The University, St Andrews (March 31)

LECTURER IN APPLIED MATHEMATICS—The Secretary and Registrar, The University, Southampton (March 31)

PROFESSOR (with a higher degree and teaching experience at university level, and with substantial research experience in the field of mathematics) OF MATHEMATICS, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (March 31)

CHAIR OF APPLIED MATHEMATICS—The Registrar, The University, Sheffield 10 (April 2)

SENIOR LECTURER IN LAND SURVEYING at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Cape Town, April 15)

CHAIR OF SURGERY in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Cape Town, April 30)

ASSISTANT CONSERVATOR (with a degree in forestry, and preferably under 40 years of age) OF FORESTS, Cyprus—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 61/17/01

ASSISTANT LECTURER IN GEOLOGY—The Registrar, The University, Nottingham

BIOCHEMIST (non-medical, senior grade, and preferably with research experience) IN THE PATHOLOGICAL DEPARTMENT, for duties which consist of routine and more advanced biochemical techniques—The Consultant Pathologist, Hill End Hospital, St Albans, Herts

BRADFORD DYERS' ASSOCIATION LIMITED RESEARCH FELLOW (with high qualifications in science), to undertake research in tinctorial chemistry, textile chemistry or an allied subject—The Principal, Technical College, Bradford

ENTOMOLOGIST (preferably with postgraduate experience) IN THE RESEARCH SECTION of the Agricultural Department, Aden, to work on cotton and other crops—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S W 1

EXPERIMENTAL OFFICER (male) (with a degree or diploma in agriculture), AT THE SCOTTISH PLANT BREEDING STATION, to take charge of the organization and conduct of field work connected with the Station's scientific programme, and an ASSISTANT EXPERIMENTAL OFFICER (male) (with a degree or diploma in agriculture or botany) to assist in the Cereals Research Section—The Secretary, Scottish Plant Breeding Station, Pentlandfield, Roslin, Midlothian

EXPERIMENTAL OFFICERS (preferably with a pass degree), and ASSISTANT EXPERIMENTAL OFFICERS (with at least H S C), with the United Kingdom Atomic Energy Authority, Foulness, Essex, to assist in the development of electronic instruments to record air shock—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 215 A/WCE/2

FIELD GEOLOGISTS (with a first- or good second-class honours degree in geology) in the Geological Survey Departments of the following territories East Africa—Kenya and Tanganyika , Central Africa—Nyasaland, Northern Rhodesia , West Africa—Federation of Nigeria, Sierra Leone , South-East Asia—Federation of Malaya , Other Territories—Somaliland Protectorate, Bechuanaland, British Guiana—The Director of Recruitment, Colonial Office, Oversea Service Division, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 104/04

LABORATORY TECHNICIAN (with experience in organic-chemistry research work) IN THE MICROBIOLOGY SECTION, for work on plant constituents—The Secretary, Department of Forestry, Imperial Forestry Institute, University of Oxford

LECTURER IN ASTRONOMY, and LECTURERS (2) IN RADIO ASTRONOMY—The Registrar, The University, Manchester 13

LECTURER (with a degree or diploma in agriculture and experience of teaching or lecturing) IN AGRICULTURE, at the Natural Resources School, Tengeru, Tanganyika—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD/63/8/06

LECTURER (with special interests in either hydro- or aero-dynamics, or in electromagnetic theory) IN MATHEMATICS—Head of the Department of Mathematics, Imperial College, London, S W 7

MASTER to teach CHEMISTRY to scholarship level—Downside School, Stratton-on-the-Fosse, Bath, Somerset

ORGANIC MICRO ANALYST (Senior Technician grade) IN THE DEPARTMENT OF CHEMISTRY—The Chief Technician, Department of Chemistry, The University, Oxford Road, Manchester 13

PHYSICIST (with a good honours degree) to assist in research into the fundamental principles underlying the processing of textile fibres into yarns—The Secretary, British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee

PLANT PHYSIOLOGIST (with, or expect to be awarded this year, a degree in natural science and training in plant physiology), at the Coffee Research Station, Ruiru, Kenya, to investigate diseases of the coffee berry—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 63/7/015

READER and SENIOR LECTURERS or LECTURERS IN PHYSICS—The Dean, College of Arts and Science, Baghdad, Iraq

RESEARCH ASSISTANT (with qualifications in mathematics, physics or chemistry) IN THE DEPARTMENT OF INORGANIC AND STRUCTURAL CHEMISTRY—Prof E G Cox, Department of Inorganic or Structural Chemistry, The University, Leeds 2

RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY, for work on the mechanisms of changes produced in polymers by radiations—The Registrar, The University, Edgbaston, Birmingham 15

SCIENTIFIC ASSISTANT FOR GREENHOUSE EXPERIMENTS, to take charge of the experimental work with sand and water cultures in connexion with investigations on the mineral nutrition of fruit crops—The Secretary, University of Bristol, Department of Agriculture and Horticulture, Research Station, Long Ashton, Bristol

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first-class honours degree in a natural science, and at least two years postgraduate research experience, preferably of freshwater fish and fisheries) at the Jinja (Uganda) Laboratories of the East African Fisheries Research Organization, to carry out research into the ecology and/or physiology of fish—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 195/194/02

TECHNICIAN IN THE DEPARTMENT OF CHEMICAL ENGINEERING, to assist in the preparation of Co enzyme "A"—The Secretary, University College, Gower Street, London, W C 1, quoting "Chem Eng /3"

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Industrial Management a Course of Lectures given at Cambridge University for the Faculty Board of Engineering, 1953 Pp 124 (Sheffield United Steel Companies, Ltd , 1954) [1512

Aero Research Technical Notes Bulletin No 143 (November 1954) Synthetic Resin Glues in the Building Industry Part 2 Some Further Notes on "Aerolite" 300 for Timber Roof Trusses Pp 5 (Duxford Aero Research Limited, 1954) [1512

Overseas Food Corporation Annual Report and Statement of Accounts for the year ended 31st March, 1954 Pp iv+70 (London H M Stationery Office, 1954) 2*s* 6*d* net [1512

Air Ministry Meteorological Office Instructions for the Preparation of Weather Maps, with Tables of the Specifications and Symbols Second edition Pp ii+49 (M O 515) (London H M Stationery Office, 1954) 1*s* 9*d* net [1512

Philosophical Transactions of the Royal Society of London Series B Biological Sciences No 653, Vol 238 (10 December 1954) *Elephantulus* Going Into Anoestrus Menstruation and Abortion By C J van der Horst The Lactation Cycle of *Elephantulus Myurus Jamesoni* (Chubb) By Muriel J McKerrow The Male Genital System and Reproductive Cycle of *Elephantulus Myurus Jamesoni* (Chubb) By Zelda G Stoch Pp 27–126+2 plates (London Royal Society, 1954) 35*s* [1512

Department of Scientific and Industrial Research Chemical Research Laboratory The National Collection of Industrial Bacteria—Catalogue of Strains maintained at the Chemical Research Laboratory, Teddington, Middlesex. Pp ii+32 (London H M Stationery Office, 1954) 2*s* net [1712

Customs and Excise Tables showing the relation between the Specific Gravity of Spirits at $\frac{20^\circ}{20^\circ}$ Centigrade and the Percentage of Ethyl Alcohol by Weight and by Volume, with corresponding percentage of proof spirit Pp iv+35 (London H M Stationery Office, 1954) 4*s* net [1712

Southern Regional Council for Further Education Seventh Annual Report, October 1954 Pp 30 (Reading Southern Regional Council for Further Education) [1712

Other Countries

Bulletin of the Central Leather Research Institute, Madras Vol 1, No 1 (August, 1954) Pp ii+26 (Issued monthly) Annual subscription 9 rupees (inland) , 18 rupees (foreign) , single issues 12 annas (Madras Central Leather Research Institute, 1954) [912

Canada Department of Mines and Technical Surveys Geological Survey of Canada Memoir No 272 Geology and Mineral Deposits of the Zeballos-Nimpkish Area, Vancouver Island, British Columbia. By J W Hoadley Pp vii+82 (5 plates) 1 dollar Memoir 273 · The Lower Mackenzie River Area, Northwest Territories and Yukon By G S Hume Pp viii+118 (3 plates) 1 dollar Memoir 276 La Poile-Cinq Cerf Map-Area, Newfoundland By J R Cooper Pp vii+62 (4 plates) 75 cents Bulletin 27 · Contributions to the Economic Geology of Western Newfoundland The Strontium Deposits of Port Au Port Peninsula By Helgi Johnson The Magnetite and Gypsum Deposits of the Sheep Brook-Lookout Brook Area By David M Baird The Iron Deposits of Indian Head Area By Allen V Heyl and John J Roman Pp vii+65 (4 plates) 50 cents Annual Report 1953, fiscal year ended March 31 Pp 98 50 cents (Ottawa Queen's Printer, 1954) [912

Indian Forest Bulletin No 180 (New Series) · Cellulose and Paper—Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board Part 18 Chemical Pulps for Writing and Printing Papers from *Sterculia alara* Roxb (*letkok*) By R V Bhat and P R Gupta Pp ii+5 (Delhi Manager of Publications, 1954) 6 annas , 7*d* [912

Indian Forest Records (New Series) Silviculture Vol 9, No. 2 Phenological Behaviour of a Few Forest Species at New Forest, Dehra Dun By V S Krishnaswamy and G S Mathauda Pp ii+89–134 (Delhi Manager of Publications, 1954) 2 rupees, 8 annas , 4*s* [912

Landwirtschaft—Angewandte Wissenschaft Lokalklimatische Untersuchungen im Raum der Harburger Berge und der benachbaeten Elbniederung Von Dr Josef van Eimern und Dipl Met Egon Kaps Pp 112 Ergebnisse von Windschutzuntersuchungen in Hamburg-Garstedt, 1952 Von Dr Josef van Eimern, Ernst Kranken und Dipl Met Heinz Harries Pp 96 (Herausgegeben vom Bundesministerium fur Ernährung, Landwirtschaft und Forsten) (Hiltrup bei Munster (Weftf) Landwirtschaftsverlag, G m b H , 1954) [1412

Berichte der Naturforschenden Gesellschaft zu Freiburg i Br 44 Band Freiburg und der Breisgau Ein Führer durch Landschaft und Kultur Von Nikolaus Creutzburg, Heinz Eggers, Werner Noack und Max Pfannenstiel Pp 312 (Freiburg im Breisgau , Verlag Hans Ferdinand Schulz, 1944) 16 D marks [1412

Norsk Polarinstitutt Meddelelser Nr 78 Landmåleriv i Dronning Maud Land Av Nils Roer Pp 245–266 2 kronor Meddelelser Nr 79 Pollen og sporer i tertiaere kull fra Vestspitsbergen Av Svein Manum Pp 10+2 plates 2 kronor Skrifter Nr 99 Eskimo Metabolism a Study of Racial Factors in Basal Metabolism By Kåre Rodahl Pp 83 10 kronor Skrifter Nr 100 Notes on Some Corals from Late Paleozoic Rocks of Inner Isfjorden, Spitsbergen By Peter Padget Pp 10 1 kronor Skrifter Nr 101 Svalbard in International Politics, 1871–1925—The Solution of a Unique International Problem By Trygve Mathisen Pp 211 18 kronor Skrifter Nr 102 Studies on the Blood and Blood Pressure in the Eskimo and the Significance of Ketosis Under Arctic Conditions Av K Rodahl Pp 79 10 kronor (Oslo Broggers Boktrykkeris Forlag, 1954) [1412

Queensland Institute of Medical Research Ninth Annual Report, year ended 30th June, 1954 Pp 13 (Brisbane Government Printer, 1954) [1512

Commonwealth of Australia—Department of External Affairs Australian National Antarctic Research Expeditions Interim Reports 1 Seal Marking at Heard Island, 1949 By R G Chittleborough and E M M Ealey Pp ii+23+6 plates (Melbourne Department of External Affairs (Antarctic Division), 1951) [1512

Editorial and Publishing Offices of " NATURE "
MACMILLAN & CO , LTD ,
ST. MARTIN'S STREET, LONDON, W C 2
Telephone Number Whitehall 8831 Telegrams Phusis Lesquare London

Annual subscription £6, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to
T. G Scott & Son, Ltd , Crown House, 143–147 Regent Street, London, W 1
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

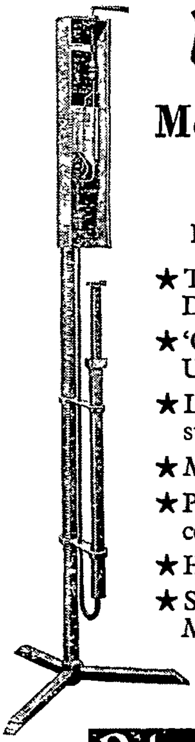
Specific Gravity Fluids

A leaflet will give details of the heavy liquids stocked for flotation tests.

They are available as plain substances which you mix as required, or in sets of mixtures at quite small subdivisions of density.

Please ask us to send a copy

RAYNER
100 NEW BOND STREET, LONDON, W 1
Telephone GRO 5081



Pulsometer

Trade Mark

McLEOD GAUGE
TYPE "G"
with
REPLACEABLE HEAD

- ★ The only breakable part is the Demountable standard Head.
- ★ 'O' Ring Sealed Vacuum Unions.
- ★ Lightweight but rigid construction. All Metal Frame.
- ★ Metal Barometric Tube.
- ★ Plunger operated giving fine control and easy operation.
- ★ Hard Gloss Finish.
- ★ Standard Ranges: .1—.00001 M/M. 10—01 M/M.

Advertisement No 3370

Pulsometer Engineering Co. Ltd.
Nine Elms Ironworks, Reading.

The Policy for Education

provides a means of saving for a child's education For example, for a parent aged 35 next birthday,

The Society pays

£100 p.a. for 5 years, beginning in 15 years' time, and if the parent dies within 15 years, £100 p.a in the meantime towards the child's maintenance

The cost is

£8 7s. 6d. a quarter for 15 years at most

Enquire for details, giving the ages of parent and child

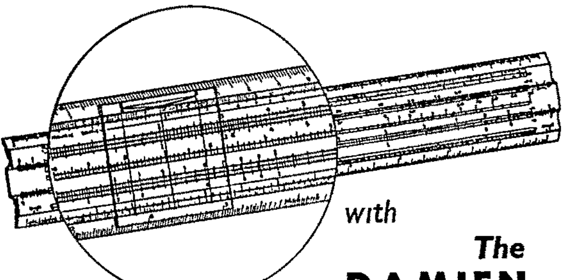
The Equitable Life Assurance Society

(founded 1762)

19, Coleman Street, London, E C.2

No shareholders No commission.

SLIDE RULE EFFICIENCY



with The DAMIEN METAL SLIDE RULE

Light . unbreakable . . . never wears out . . . indifferent to atmospheric or other conditions. Photographic printing ensures absolute accuracy, while the silver-grey finish gives figures maximum legibility Retail price £3 3s. 0d. each

SPECIAL REDUCED PRICES FOR OVERSEAS

Obtainable from leading stationers and Drawing Office suppliers or direct from

ANODISED PRODUCTS Ltd.
91 Upper Thames Street, London, E.C.4
Telephone. MAN 7765

LECTURES AND COURSES

UNIVERSITY OF BIRMINGHAM

INSTITUTE FOR ENGINEERING PRODUCTION

EXECUTIVE COURSES ON PRODUCTIVITY STUDIES

A number of short practical courses on the principles and methods of increasing productivity are now available for production directors, works managers and senior production engineers on the following subjects

February 28 to March 11, "Work Study Applied to Secure Process and Product Improvement"

March 14 to March 25, "The Use of Operational Research in Increasing Productivity"

March 28 to April 7, "The Application of Work Study"

April 18 to 29, "Production Planning and Control"

May 2 to 13, "Work Study Applied to Secure Process and Product Improvement"

May 16 to 27, "The Use of Operational Research in Increasing Productivity"

June 6 to 17, SUMMER COURSE, on "Work Study with particular reference to Industrial Training Methods"

June 20 to July 1, SUMMER COURSE on "The Application of Work Study"

These courses may be attended singly or in sequence, and residential facilities are available for 25 members on each course Further information is available from The Senior Courses Secretary The Institute for Engineering Production, "Southfield," 16 Norfolk Road, Edgbaston, Birmingham, 15 Tel No EDG 0390

UNIVERSITY OF LONDON

A course of two lectures on "Some Infertility Factors in Domestic Animals" will be given by Professor Nils Lagerlof (Royal Veterinary College of Sweden) at 4 p m, on March 3 and 4 at the Royal Veterinary College, Royal College Street, N W 1

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

UNIVERSITY OF LONDON

A course of two lectures on "Mechano-Chemistry of Muscle" will be given by Academician W A Engelhardt (Moscow) at 5 30 p m, on March 8 and 16 at Westminster Medical School (Meyerstein Lecture Theatre), Horseferry Road, S W 1

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

UNIVERSITY OF LONDON

A lecture on "Full Utilization of Pasture" will be given by Dr H J Frankena (Inspector of Agriculture, Wageningen, Netherlands), at 8 15 p m on March 3 at Wye College, Wye, near Ashford, Kent

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged* 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive, unless he or she, or the employment is excepted from the provisions of the Notification of Vacancies Order 1952

KUMASI COLLEGE OF TECHNOLOGY

(Principal W E Duncanson, Ph D, D Sc, F Inst P)

Vacancies exist for (1) Senior Lecturer in Physics (2) Lecturer in Physics (3) Three Lecturers in Mathematics (4) Two Lecturers in General Science (5) Lecturer in Chemistry (6) Lecturer in English Salary scales Senior Lecturer, £1 400 to £1,850 per annum, Lecturer £880 to £1,560 per annum Initial salary according to experience Posts are pensionable but temporary appointments carrying gratuities and 10 per cent higher salaries might be made Partly furnished houses provided rent according to salary Free first-class passages to and from Gold Coast for persons appointed wives and up to three children under 13 Generous home leave, normally annual

Write for further information to Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W C 1 Closing date for applications (six copies) March 7, 1955

COMMONWEALTH of AUSTRALIA

DIVISION OF RADIOPHYSICS

APPOINTMENT NOS 780/111 to 780/113 OF RESEARCH OFFICER

The Commonwealth Scientific and Industrial Research Organization invites applications for research appointments to the Division of Radiophysics, which is located within the grounds of Sydney University The Division has a modern and well equipped laboratory and has vacancies in three recently developed fields of research Radio Astronomy, a modern branch of astronomy which is concerned with the study of extra-terrestrial bodies by means of the radio radiation which they emit, Rain and Cloud Physics, an investigation of the physical processes which lead to cloud and rain, both natural and artificially induced, the physics of Semiconductors and in particular of Transistors, and their applications in electronics Applicants should possess a university honours degree with physics as major subject and mathematics to a high standard A good knowledge of modern electronic techniques would be a desirable but by no means essential advantage Applications from recent graduates and from physicists with postgraduate research experience will be considered Appointment will be made within the classification of Research Officer (salary range £A 1 184 to £A 1,730 per annum), and at a level depending on previous training and experience Those selected will be offered, according to their qualifications and experience, either (i) A short-term appointment (two to three years), with the possibility of further extension, or (ii) a more permanent appointment to the research staff The appointments will be conditional on a satisfactory medical examination and officers appointed under (ii) may be granted superannuation privileges Fares to Australia (including those of wife and family) will be paid Position 780/111—for work on radio astronomy Position 780/112—for work on cloud and rain physics Position 780/113—for work on transistors

Applications, referring to the appropriate appointment number and stating full name, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by names and addresses of two persons willing to act as referees, if required, and copies of not more than four testimonials, should reach the undersigned, not later than March 26 1955

W IVES,
Chief Scientific Liaison Officer

Australian Scientific Liaison Office,
Africa House,
Kingsway, London, W C 2

UNITED BIRMINGHAM HOSPITALS

QUEEN ELIZABETH HOSPITAL, BIRMINGHAM, 15

Applications are invited from graduates in Biochemistry or Chemistry for the post of Biochemist (basic grade) in the Biochemical Laboratory Salary and superannuation according to National Health Service Whitley Council Scale

Applications, together with two testimonials, should be sent to the House Governor

---

CENTRAL RESEARCH ESTABLISHMENT National Coal Board (at Isleworth, Middlesex) invite applications for superannuable appointments as Scientists and Engineers Candidates should have a degree in physics, metallurgy, mechanical or electrical engineering or equivalent professional qualification, and preferably some experience in research The work embraces (a) the mechanical properties of coal, (b) technical processes of winning coal from the seam, (c) behaviour of the surrounding strata during and after removal of coal from the seam, (d) design of experimental coal-winning machinery embodying new principles, (e) the transport of coal underground by belt conveyors, (f) metallurgical problems arising in mining, (g) environmental problems—(i) temperature and humidity conditions underground (ii) the instrumentation of methane, (iii) the assessment and suppression of dust, (h) development of mechanical, electrical and electronic instruments for use in laboratory and underground Much of this work will be carried out initially in the laboratory, although staff will be required to continue their experiments underground when required Salary on appointment according to age and experience, will be in the Scientist Grade III scale £500 by £25 to £950 male, plus London location allowance of £34 minimum, rising to £66 at maximum scale—Write, giving full particulars (in chronological order) of age education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, marking envelope TT/929 Original testimonials should not be forwarded Closing date March 29, 1955

GOVERNMENT OF NORTHERN IRELAND

CIVIL SERVICE COMMISSION

Applications are invited for a permanent an pensionable post of Scientific Officer in the De partment of Industrial and Forensic Science of th Ministry of Commerce The salary scale, whic attracts pay supplement of amounts betwee £22 10s and £30 per annum, is, for men, £470 b £30 to £680 by £35 to £855, and for women £47 by £25 to £545 by £30 to £750 Candidate should have a first- or second-class honours degre in an approved scientific subject or other approve equivalent qualification Previous industrial e perience will be an advantage Preference will b given to suitably qualified ex-Service candidat who served in the 1914-18 or 1939-45 wars, pro vided the Commissioners are satisfied that suc candidates are, or within a reasonable time w be, able to discharge the duties of the po efficiently

Application forms and further particulars ma be obtained from the Secretary, Civil Servi Commission, Stormont, Belfast, to whom th should be returned, duly completed, with copi of two recent testimonials, so as to reach him n later than April 1, 1955

UNIVERSITY OF LIVERPOOL

Applications are invited for the following Fe lowships (i) I C I Research Fellowships Physics, Chemistry, Engineering, Metallurgy a Pharmacology, or any related subject, to whi some appointments may be made during the cu rent academic year The appointments will da from October 1, 1955 The salary will depe upon qualifications and experience, but will no mally be within the range £600 to £900 per annu together with F S S U benefits and family allo ances (ii) Two Leverhulme Postgraduate Fe lowships in the Faculty of Science, tenable f one year at a value of £500, renewable for second year at a value of £550

Applications, three copies, stating the Fello ship applied for, age details of qualifications a experience, publications, research work in progre and completed, and an outline of the propos field of research, and, in the case of the Leve hulme Fellowships, whether National Service r quirements have been fulfilled, together with t names of two referees, should be received n later than March 1, 1955, by the undersigne from whom further particulars may be obtaine (Candidates overseas who find it more convenie to do so may send one copy only by airmail)

STANLEY DUMBELL,
Registrar

MONMOUTHSHIRE EDUCATION COMMITTEE

THE TECHNICAL COLLEGE OF MONMOUTHSHIRE, CRUMLIN

Dr T V Starkey Principal

Required on April 1 or as soon as possi thereafter (a) Lecturer in Chemistry Candida must possess a good honours degree or Associa ship of the Royal Institute of Chemistry and ha had research and/or industrial experience Tea ing experience would be an added qualificati The post involves the teaching of chemistry graduate level (b) Lecturer in Physics Can dates must possess a good honours degree Associateship of the Institute of Physics and ha had research and/or industrial experience Tea ing experience would be an added qualificati The post involves the teaching of pure and appl physics to graduate level In both posts resea is regarded as an official duty The salary to paid for each post will be at the Lecturer Gra of the Burnham Report (£965 by £25 to £1,06

Further particulars and forms of application tainable from the undersigned, must be return by March 12, 1955

C E GITTINS
Director of Educati

County Hall,
Newport, Mon

BATTERSEA POLYTECHNIC

LONDON, S W 11

Applications are invited for a Grade B Lectu to teach Science as applied to Catering and all subjects Applicants should be graduates of British university with chemistry as one of th subjects and a knowledge of nutrition or hyg would be an advantage Salary, men £621 £633 by £25 to £928 women £559 or £571 by to £763, plus allowance of £30 and £24 resp tively for a good honours degree, a training all ance and increments for industrial or research perience

Further particulars from the Clerk to Governing Body, by whom applications should received as soon as possible

COMMONWEALTH of AUSTRALIA

DIVISION OF BUILDING RESEARCH
APPOINTMENT NO 390/209 OF RESEARCH OFFICER

The Commonwealth Scientific and Industrial Research Organization invites applications for appointment to a position of Research Officer at its Division of Building Research, Highett, Victoria Duties to participate in a programme of theoretical and experimental research on the properties and uses of lightweight concrete and gypsum plaster as structural materials Qualifications University honours degree in engineering or science or equivalent qualifications Salary Dependent on qualifications and experience commencing salary will be determined within the range of Research Officer, £A 1,184 to £A 1,730 per annum actual, thirteen increments with efficiency review at £A 1,268 to £A 1,520 per annum actual Fare to Australia (including those of wife and family) will be paid The appointment is subject to satisfactory medical examination and the appointee may be granted superannuation privileges

Applications, referring to Appointment No 390/209 and stating full name place, date and year of birth, marital state, nationality, present employment particulars of qualifications and experience, and of war service (if any), accompanied by copies of not more than four testimonials and the names and addresses of two persons willing to act as referees, if so required, should reach the undersigned not later than March 26, 1955

W IVES,
Chief Scientific Liaison Officer
Australian Scientific Liaison Office,
Africa House,
Kingsway, London, W C 2

CITY OF CARDIFF EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY AND COMMERCE

Applications are invited for the post of Assistant Lecturer Grade B in the Department of Applied Physics and Electrical Engineering Candidates should have a good honours degree in physics or electrical engineering Some research, industrial or teaching experience is essential A knowledge of telecommunications would be an advantage The present salary scale for an Assistant Lecturer Grade B is £525 by £25 to £820 per annum, plus appropriate allowances for training and degree Applicants with suitable professional or industrial experience (after the age of 21) may be started higher up the scale at the rate of one increment of £18 for each year of such experience

Forms of application, together with further particulars may be obtained from the undersigned on eceipt of a stamped addressed foolscap envelope, and should be returned as soon as possible

ROBERT E PRESSWOOD,
Director of Education

City Hall,
Cardiff

MIDDLESBROUGH EDUCATION COMMITTEE

CONSTANTINE TECHNICAL COLLEGE

Principal D A R Clark, M Sc (Tech),
M I Mech E

Required for September 1, 1955 Lecturer Engineering (preference will be given to appliants with experience in soil mechanics and geology) Assistant Lecturers Grade B Electrical ngineering, mechanical engineering, structural ngineering, mathematics Assistant Lecturer Grade A Mechanical engineering, mathematics, physics Salary Burnham Technical Scale Lecturer £965 by £25 to £1 065 , Assistants Grade B, 525 by £25 to £820 , Assistants Grade A £450 by £18 to £725 (together with usual allowances or degree, training and industrial experience in ase of Assistants)

Forms and particulars obtainable from Director of Education Woodlands Road, Middlesbrough o whom completed applications should be reurned within fourteen days of the appearance of his advertisement

---

UNIVERSITY COLLEGE LONDON (GOWER treet, W C 1) requires full-time Research Assistant (man or woman) in Department of Anatomy Professor J Z Young), for work mainly on the central nervous system Duties to commence May 1, 1955 or as soon as possible thereafter reference to candidates with honours degree in medical sciences or biology , knowledge of German desirable Salary £600 per annum, with amily allowances —Applications, to be received by March 26 1955, should be sent to the Secretary, from whom further particulars may be obtained

---

PLANT BREEDING INSTITUTE

CAMBRIDGE

Applications are invited for the post of Scientific Officer in the Forage Crops Section to engage in genetical, physiological and breeding research in grasses and legumes Good honours degree in science essential Starting salary within range of £467 10s to £845 per annum, with F S S U benefits

Applications, with names of three referees, to be sent to the Secretary, Plant Breeding Institute, Trumpington, Cambridge, before March 16

COUNTY OF LEICESTER

LOUGHBOROUGH COLLEGE OF FURTHER EDUCATION

Applications are invited for an Assistant to teach physics to advanced level G C.E , and engineering physics to the requirements of the I E E , and to take up duties on, or before, September 1, 1955 Ability to teach chemistry to G C E ordinary level and to supervise the equipping and maintenance of science laboratories would be advantages Salary is in accordance with the Burnham Technical Scale, Grade B viz , £525 by £25 to £820, with appropriate allowances for degree, training, teaching and industrial experience

Further particulars and application form, which is to be completed within fourteen days of this advertisement, can be obtained from the undersigned

D J LYSAGHT, M Sc , Ph D ,
Principal
Loughborough College of Further Education
Loughborough

UNIVERSITY OF CAMBRIDGE

Applications are invited for a University Demonstratorship in Veterinary Anatomy The person appointed will be expected to take office from October 1, 1955 An honours degree in some branch of natural science is essential A veterinary qualification and experience in teaching the subject will be considered an advantage

Full particulars can be obtained from Dr A S Watt, Botany Department, Downing Street, Cambridge, to whom applications (ten copies), and the names and addresses of not more than three referees should be sent, to reach him not later than April 1, 1955

UNIVERSITY OF SHEFFIELD

Applications are invited for the post of Lecturer in Refractory Materials in the Department of Metallurgy, to begin duties as soon as possible Salary scale £650 by £50 to £1,350, with F S S U provision and family allowance Initial salary according to qualifications and experience

Further particulars should be obtained from the Registrar to whom applications (four copies) should be sent by March 31, 1955

UNIVERSITY OF GLASGOW

LECTURESHIP IN CHEMISTRY (ORGANIC CHEMISTRY)

Applications are invited for a Lectureship in Chemistry (Organic Chemistry), tenable from October 1, 1955 Salary scale £650 to £1,350 Initial salary according to experience and qualifications F S S U and family allowance benefits

Applications (six copies), should be lodged not later than March 12 1955 with the undersigned, from whom further particulars may be obtained

ROBT T HUTCHESON
Secretary of University Court

PHYSICISTS REQUIRED BY MINISTRY OF Supply for Research and Development Establishments mainly in Southern England Should have sound basic training in physics and be prepared to apply their knowledge to problems in fields including aircraft, instrumentation and electronics Prospects of promotion to higher grades Not established but opportunities to compete for establishment may arise Qualifications Scientific Officer Class, first- or second-class honours degree or equivalent Experimental Officer Class higher school certificate (science) or equivalent, but higher national certificate pass degree, etc , may be an advantage Salary, according to age, research experience, etc , as Scientific Officer, within range £467 10s to £845 , Experimental Officer (minimum age 26), £715 to £880 , Assistant Experimental Officer, £288 10s (age 18) to £640 Women somewhat less F S S U benefits may be available for Scientific Officer class —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A34/5A

COMMONWEALTH of AUSTRALIA

DEPARTMENT OF HEALTH

Senior Research Officer, Plant Quarantine Section, Canberra Salary £A 1,394 to £A 1,646 per annum Duties Research and investigation into matters affecting plant quarantine involving liaison and co-operation with appropriate Institutions and technical workers in Australia Collection of technical data relating to plant quarantine administration Qualifications University degree in agricultural science or science of an Australian University, or of an overseas university of equivalent standing , or equivalent qualifications which should include a university degree supported by special postgraduate experience in research and/or teaching in plant pathology A sound general knowledge of agriculture, postgraduate research, and/or teaching in plant pathology, experience in conference work and in co-operation with other technical experts are desirable

Applications to The Chief Commonwealth Medical Officer, Australia House, London, W C 2, by March 19, 1955

MEDICAL RESEARCH COUNCIL

Applications are invited for the post of Research Assistant in the Climatic and Working Efficiency Unit of the Medical Research Council at the Department of Human Anatomy in the University of Oxford, to take part in fundamental studies of muscle and joint action and the application of this to clinical, industrial and service problems Candidates should have a medical degree or an honours degree in physiology or zoology The salary will be dependent on qualifications and experience Superannuation provision will be made under the Federated Superannuation System for Universities

Applications, giving age, qualifications, experience list of published work and copies of testimonials, should reach Professor Sir Wilfrid Le Gros Clark, F R S , Department of Human Anatomy, University Museum, Oxford, not later than April 30, 1955

CENTRAL RESEARCH ESTABLISHMENT, National Coal Board (at Isleworth, Middlesex) invite applications for the superannuable appointment of an Engineer to carry out research on coal winning The initial object is to study the fundamental principles involved in the technical process of cutting coal with a chain coal cutter This will be done with rig experiments on the forces involved in drawing a tool through coal and their variation with depth of cut, speed of traverse, slope of tool, etc Subsequently the findings will be confirmed by pit trials Candidates should have a good honours degree in mechanical engineering or equivalent professional qualifications, and preferably some experience in research Appointment will be according to qualifications and experience as either Scientist II (scale £800 by £35 to £1,150 male), or Scientist III (scale £500 by £25 to £950 male), London location allowance of £34 at the minimum rising to £82 at the maximum of the scales is payable in addition —Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, marking envelope TT/931 Original testimonials should not be forwarded Closing date March 12, 1955

THE UNITED KINGDOM ATOMIC ENERGY Authority invites applications for Assistant Experimental Officers and Assistants (Scientific) for general chemical, physical and analytical duties on shift, at its Chemical Services Laboratories, Springfield Works, near Preston Applicants for the Assistant Experimental Officer posts should have a higher school certificate, or equivalent in science subjects, and for the Assistant (Scientific) posts, candidates should have a school certificate with a credit in a science subject, or equivalent Salary for the Assistant Experimental Officer posts will be assessed according to age and qualifications between £310 (at age 18) to £685 per annum, and for the Assistant (Scientific) posts between £235 (at age 16) to £550 per annum In addition, there is a shift allowance of approximately £52 per annum, in each case There is a contributory superannuation scheme and travelling expenses in excess of 4s per week are refundable to officers receiving less than £605 per annum Career prospects and leave allowances are good, and opportunities for permanent day work occur from time to time —Applications to The Works General Manager, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, Springfields Works, Salwick, near Preston Lancs, quoting 824

TECHNICIAN REQUIRED AT ONCE WITH experience of Histological Technique for research laboratory —Apply Secretary, Institute of Dermatology, St John's Hospital for Diseases of the Skin, Lisle Street, Leicester Square, W C 2

ST BARTHOLOMEW'S HOSPITAL
LONDON, E C 1

Applications are invited for the post of Chemical Pathologist to the Hospital and Lecturer in Chemical Pathology to the Medical College, tenable as from July 1, 1955 The successful candidate will be on a full-time salary basis part of which will be paid by the hospital and part by the medical college The appointment will be subject to a satisfactory health report

Applications, together with the names of three referees should be received not later than April 1 1955 and should be addressed to C C Carus-Wilson Clerk to the Governors

INSTITUTE OF UROLOGY
IN ASSOCIATION WITH ST PETER'S
ST PAUL'S AND ST PHILIP'S HOSPITALS

Full-time Biochemist (science degree or medical qualifications essential) required for work in connection with urological disease Experience of routine biochemical tests and an interest in research necessary The post is of senior grade and Whitley Council scales will apply

Apply Secretary Institute of Urology, 10 Henrietta Street W C 2 stating age qualifications and experience and enclosing copies of two recent testimonials Closing date March 12 1955

N I A E SCOTTISH STATION

Scientific Officer required for research on agricultural engineering projects particularly the performance of tractors and implements on hillsides An honours degree (or equivalent) in mechanical engineering essential and previous research experience with strain gauge equipment a considerable advantage Salary scale £467 10s to £845, plus at present 3 per cent extra duty allowance

Further particulars of duties details of commencement salary and superannuation and application form from the National Institute of Agricultural Engineering Scottish Station, Howden Mid-Calder Midlothian

BRADFORD EDUCATION COMMITTEE
TECHNICAL COLLEGE BRADFORD
BRADFORD DYERS' ASSOCIATION
RESEARCH FELLOWSHIP

Applications are invited for a Research Fellowship provided by the Bradford Dyers' Association Limited and tenable in the College for two years The minimum value of the Fellowship will be £600 per annum the commencing rate depending upon qualifications and experience The Fellow should hold high qualifications in science He will be required to undertake research in the College in tinctorial chemistry textile chemistry or an allied subject

Forms of application may be obtained on application to the Principal, Technical College, Bradford

THE UNITED KINGDOM ATOMIC ENERGY Authority at Risley near Warrington requires a Metallurgist to be responsible to a Senior Technical Control Officer for the co-ordination of the activities of the Operations Branch in the production of suitable metals alloys and cartridges for use in various nuclear reactors and for the correlating of research and development activities with operational experience in various establishments Applicants must have an honours degree in metallurgy or have equivalent qualifications and practical and theoretical experience of solid state physics is very desirable Salary will be assessed according to qualifications and experience within the scales £1 425 to £1 620 per annum or £1 065 to £1 370 per annum The successful candidate will be required to join the Authority's contributory pension scheme —Applications to THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY Industrial Group Headquarters Risley Warrington quoting 823

COMPUTOR REQUIRED BY MINISTRY OF Supply National Aeronautical Establishment Bedford to take charge of preparation of computing programmes and supervise staff engaged on Hollerith punched card machines and the operation of Hollerith electronic computing equipment Qualifications higher school certificate (science) including mathematics Pass degree in mathematics or experience in computing an advantage Training course given soon after appointment Appointment in Experimental Officer class and salary assessed according to age and experience within range £288 10s (age 18) to £880 Women somewhat less Not established but opportunities to compete for establishment may arise —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K) 26 King Street London S W 1 quoting A 47/5A Closing date March 19 1955

NEW SOUTH WALES DEPARTMENT OF AGRICULTURE
WAGGA AUSTRALIA
AGRICULTURAL RESEARCH INSTITUTE
CEREAL TECHNICIAN

Applications are invited for the above position Salary in the range £A 897 to £A 1 067 per annum rising to £A 1 271 per annum, subject to specified conditions Appointee will be responsible for the technical work involved in the assessment of wheat quality including laboratory milling tests on dough quality and experimental bread making Experience in this type of work essential Appointee should have the Intermediate B Sc or equivalent qualification Science background an advantage Accommodation for married and single men being erected Appointee will be eligible subject to medical examination to contribute to the State Superannuation Fund Shipping fares to Sydney of appointee and family will be paid

Four copies of applications (together with four copies of testimonials and other supporting documents) should be lodged with the Agent-General for New South Wales 56 Strand London W C 2 (from whom further particulars can be obtained), by March 14 1955

LAW HOSPITAL
CARLUKE, LANARKSHIRE

Applications are invited from science graduates for the post of Biochemist (non medical) at Law Hospital The successful applicant will work under the direction of the Consultant Biochemist Salary and conditions of service based on Whitley Council scales either on the basic grade or senior grade according to experience and qualifications Single accommodation available if desired

Applications stating age, qualifications and experience together with the names of two persons to whom reference can be made, to be addressed to The Group Secretary and Treasurer Board of Management Law Hospital Carluke

UNIVERSITY OF SOUTHAMPTON

Applications are invited for the post of Lecturer in Applied Mathematics Salary depending on qualifications and experience within the range £650 to £1 350 per annum together with F.S S U and children s allowances

Further particulars may be obtained from the Secretary and Registrar to whom applications (six copies) should be sent not later than March 31, 1955

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Assistant Lecturer in Theoretical Physics Salary on a scale £450 to £550 per annum (salary scales are at present under review) Membership of F S S U and children's allowance scheme

Applications should be sent not later than March 16 1955 to the Registrar The University Manchester 13 from whom further particulars and forms of application may be obtained

ST THOMAS' HOSPITAL
LONDON S E 1

Laboratory Assistant or Radiographer required for measurements in applications of radioactive isotopes to medical problems Qualifications in science mathematics or radiography desirable Grading of posts and salary dependent upon qualifications and experience

Applications giving age experience, qualifications and names of two referees to the Personnel Officer by March 12 1955

MATHEMATICIANS REQUIRED AT VARIous Ministry of Supply Research and Development Establishments in Southern England Qualifications First- or second-class honours degree in mathematics preferably with some research experience in an applied field Appointments in Scientific Officer grade Salary range £467 10s to £845 Women somewhat less F S S U benefits may be available Prospects of promotion to Senior Scientific Officer (minimum age 26) within salary range £970 to £1 125 Not established but opportunities to compete for establishment may arise —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street London S W 1, quoting A28/5A

UNIVERSITY OF LONDON, KING S COLlege will require on October 1, 1955, a Lecturer in Vertebrate Zoology The duties will include responsibility for the organization of the teaching in that subject Salary scale £700 by £50 to £1 000, £1 050 by £50 to £1 400 with family allowances and superannuation benefits —Particulars and application forms should be obtained from the Registrar King s College, Strand W C.2, whom completed applications must reach by March 18

UNIVERSITY OF ALBERTA
FACULTY OF AGRICULTURE

Applications are invited for the position c Assistant Professor of Soil Science duties t commence on September 1 1955 Initial salary $4 000 to $5,000, depending on qualifications an experience There is a cost of-living bonus c about $300 and the normal yearly increment i $250 Preference will be given to a universi graduate with a Ph D degree or equivalent training who has specialized in soil science Dutie will include research teaching soil testing, an extension work in soil science Confirmatio of the appointment will be subject to the satisfactory completion of a probationary period c two to four years

Applications should be addressed to the Hea of the Department of Soil Science, Faculty c Agriculture University of Alberta Edmonto Alberta and should give details of training an experience personal information the names c three referees and be accompanied by a recen photograph Closing date May 1 1955

COURTAULD INSTITUTE OF BIOCHEMISTRY
MIDDLESEX HOSPITAL LONDON W 1

Applications are invited from qualified bic chemists for work on the quantitative determina tion of oestrogens Experience of isotope tech n que advantageous Salary £750 per annum

Applications stating age, experience shoul reach the Secretary not later than March 26 195

READER AND SENIOR LECTURERS O Lecturers in Physics —The Dean College of Ar and Science Baghdad Iraq

APPOINTMENTS VACANT

TECHNICAL LIBRARIAN
WOMAN

Courtaulds Limited require a technical libraria (woman) for a new research laboratory Coventry Candidates should have a knowled of chemistry to degree standard and previous experience in an industrial technical library

Candidates should write for a detailed form application to the Director of Personnel Cour aulds Limited 16 St Martin s le Grand Londo E C 1 quoting the reference number D 60

CANADA OUTSTANDING PROSPECT exist for Electro-mechanical Engineers in expan ing Canadian Company situated in the attracti City of Ottawa concerned with design and de velopment of Aircraft instruments navigati instruments guided weapons fire control equi ment flight simulators etc Openings availab immediately for electro-mechanical engineers wi a knowledge of servo-mechanisms and with tw or more years of practical experience in desi and development of the type of equipment list above Engineers should possess a degree equivalent from a university or recognized techn cal college and be 27 years of age or old Salaries in the range $6 000 to $8 000 per annu and include fringe benefits such as health an accident insurance, sick leave and holidays w pay A five-day forty-hour week is work Assistance in passage to Canada can be arrang Interviews will be arranged in London during week March 7 to 11 —Applications to the Sec tary, The Professional Engineers Appointme Bureau 9 Victoria Street, London S W 1, m be received not later than March 5

RESEARCH CHEMIST THE BRITIS Drug Houses Ltd have a vacancy in their Ch mical Research Laboratories for a young wom graduate interested in steroid chemistry Previo experience desirable but not essential —Wr giving details of studies experience, if any a age to Staff Manager, Graham Street, City Roa N 1

RESEARCH ENGINEERS HONOU graduates preferably with some postgraduate industrial research experience capable of pl ning and controlling research work on a w range of mechanical engineering problems incl ing materials structures, mechanisms and h transfer Wide scope and good prospects men with initiative Age 25 to 30 approximate —Applicants should write to Manager Resea Department Metropolitan-Vickers Electrical Ltd Trafford Park Manchester 17 giving statement of their age qualifications and expe ence and suitable references

LADY CHEMIST GRADUATE OR H N required for analysis of electroplating and al solutions —Apply Electro-Chemical Engineer Co Ltd , 161 Queens Road Weybridge Surr

JOSEPH LUCAS LTD.

offer opportunities in

LIGHT ENGINEERING

for University Graduates with
Science and Engineering Degrees

Interviewing of applicants is now in progress for Post Graduate Training Courses commencing this Autumn A few vacancies for direct employment with this Organisation are also available for Graduates with suitable qualifications Further particulars can be obtained from the Secretaries, Universities Appointments Boards, or from the **Personnel Manager, Joseph Lucas (Electrical) Ltd , Great King Street, Birmingham, 19, quoting reference PM/D'61.**

SENIOR RESEARCH CHEMIST IS RE- uired by Imperial Smelting Corporation Limited › carry out investigations into the preparation f fluorine containing polymers and the determina- on of properties of the polymers Applicants iould preferably have had relevant experience f polymer or fluorine research work and possess 1 honours or postgraduate degree, although ap- ications will be entertained from persons ss qualified, but with relevant experience — pplications to Personnel Manager, Imperial nelting Corporation Ltd , St Andrew's Road vonmouth, near Bristol, quoting reference RG/N

WANTED TECHNICAL ASSISTANT FOR les and office routine in connection with ap- iratus for X-ray crystallography A general iowledge and experience of X-ray crystallo- aphy and technical engineering subjects is essen- il together with ability to deal with correspon- nce Age between 25 and 40 —Solus-Schall, mited, 18-22 New Cavendish Street, London, ' 1

REVERTEX LTD , HARLOW, ESSEX RE- ire a chemist for technical service work on bber latex and synthetic resin emulsions Hous- g available at controlled rents Good oppor- nties for travel —Full details to Chief Chemist

---

PHILIPS RESEARCH LABORATORIES RE- ire a graduate chemist (female) with general gree or Inter B Sc for important routine asurements on materials and components as ed in the electronics ndustry Age not over years Interesting work in modern laboratory uated on southern outskirts of London Good mmencing salary will be paid according to age, ility and experience —Please apply in writing the Personnel Officer Philips Electrical Indus- es Ltd , New Road, Mitcham Junction, Surrey, oting the reference M R 146/MBL

BRITISH NYLON SPINNERS LIMITED RE- ire an Information Assistant in their Library d Information Section The work will be ried and includes indexing of technical literature d the making of literature surveys The mini- im qualification is general certificate of educa- n advanced level, with chemistry as one sub- t but persons with higher qualifications or ex- ience in a technical library will be given ference The appointment is permanent and isionable Five-day week —Apply in writing to sonnel Manager Pontypool Mon

---

THE UNITED GLASS BOTTLE MANUFAC- ers Ltd require for research and development rk honours graduates in engineering physics, mistry or fuel technology with or without re- rch or plant experience Competitive salary ording to qualifications and experience Ex- lent prospects on research and production — ply in writing to, Personnel Manager The ited Glass Bottle Manufacturers Ltd 8 cester Street London W C 2

T & H SMITH LTD HAVE A VACANCY their works at Edinburgh for a qualified irmacist or chemist under 35 years of age, for resting work in connection with the develop- nt and production of allergy preparations erannuation scheme in force —Apply giving personal particulars to Works Director, T H Smith Ltd Blandfield Chemical Works, heatfield Road Edinburgh 11

ENGLISH CLAYS LOVERING POCHIN & Ltd St Austell Cornwall, have vacancies the Research Department for (1) an Inorganic emist with postgraduate experience, (2) a aduate Physical Chemist —Application in con- ence to the Research Manager

---

A SCIENCE GRADUATE WHO IS INterested in a progressive career in modern manufacturing is required by a large and growing company with chemical interests During the last 25 years the company has met its expansion needs by the introduction of graduates of progressive outlook who wished to make a career in modern industry, and who wished to develop in the managerial and executive field without losing touch with technical matters Most of these men have read chemistry, but it has appealed also to the engineer or physicist who wished to veer away from the purely technical field The initial position, after training will be the management of a small process or production department The position will be clearly defined in both responsibility and authority and will be preceded by careful training under senior graduate members This training will be continued long enough to ensure the position is taken over with confidence Two other positions of a similar nature will be available later in the year, and applications from interested graduates taking finals this summer, or from men in the Services, will be considered now Upper age limit 27 years Commencing salary £650 to £850 depending upon the candidate's background, and this will be paid during the training period At the end of training full scope will be given for the use of ability and initiative and progress will be related solely to merit All senior positions are without exception filled from within the company Strict confidence will be observed —Please forward a brief outline of background, etc , to Box 648, T G Scott and Son, Ltd , 143-147 Regent Street, London W 1

JOSEPH LUCAS, LIMITED HAVE AN INteresting vacancy in their research and development laboratories which would be suitable for a young graduate with honours degree in mathematics or physics The work is largely of a fundamental nature and is concerned with acoustics and mechanical vibrations Previous industrial experience is not necessary —Please reply, giving qualifications, age, and any other relevant details to Personnel Manager, Joseph Lucas (Electrical) Ltd , Great King Street, Birmingham, quoting reference PM/D/59

TUBE INVESTMENTS RESEARCH Laboratories require a young scientist for work in polymer research and measurements of properties of plastics Excellent prospects for advancement as a member of a team engaged on fundamental research in a vital new field —Apply giving qualifications and experience, to the Secretary, Tube Investments Research Laboratories Hinxton Hall Saffron Walden

---

A SPONSORED RESEARCH ORGANIZAtion requires young Organic Chemists, male or female with honours degree or equivalent for research and development work Recently graduated applicants would find this an interesting opening to industrial research Applications are also invited from organic chemists for a more senior position —Full particulars, in confidence, to J A Radley, Industrial Research and Development Laboratories Elgar Road, Reading

---

A GRADUATE IS REQUIRED FOR BASIC and applied research on the machining and cold forming of metals A good degree (or equivalent qualification) in engineering, science or metallurgy is required There are good prospects for advancement Commencing salary commensurate with qualifications and experience Pension scheme —Send full details, including age experience qualifications and present salary in confidence to Box 649, T G Scott and Son Ltd 143-147 Regent Street, London, W 1

RESEARCH AND DEVELOPMENT

Courtaulds, Ltd , invite applications for the following vacancies in their Research and Development Laboratories, Bocking Braintree, Essex Graduate Textile Technologist, age 27-32, with industrial experience to work on textile dyeing and finishing Ref No D 61 Graduate Textile Technologist, to work on Research and Development in the field of textile manufacture Ref No D 62 Graduate Chemist, age 33 or less, for work on textile sizing Ref No D 63

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Limited, 16 St Martin's-le-Grand, London, E C 1, quoting the appropriate reference number

---

CHEMIST

HONOURS GRADUATE

Courtaulds, Ltd , has a vacancy in its Textile Research Laboratory at Bocking Essex, for a Graduate Physical Chemist who is interested in the basic physical problems of textile chemistry and is prepared to contribute original ideas in a developing situation Applicants should possess an honours degree and have had practical experience of research methods Age 25 to 33

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds, Ltd , 16 St Martin's-le-Grand London, E C 1, quoting the reference number D 64

MULLARD RESEARCH LABORATORIES invite applications from honours graduates to carry out research and development on the application of new magnetic materials to computors Initially, the work will be concerned with digital storage and information-handling devices incorporating ferrite cores

Postgraduate experience in either computor techniques, transistors or magnetic devices would be an advantage The work calls for a high degree of individual responsibility and there is great scope for initiative and inventiveness Publication of results will be encouraged

Salaries based on qualifications, experience and age, and are in keeping with present-day levels General prospects within the organization are excellent

Applications to

Mr G A Taylor,
Personnel Manager,
Mullard Research Laboratories,
Cross Oak Lane, Salfords,
near Redhill, Surrey,
quoting reference, E R L

APPLICATIONS ARE INVITED FROM recently qualified chemists for an interesting and progressive post in a cereal laboratory The work will involve non-routine analysis and research Applicants should be in the 20-25 age group Five-day week and pension scheme in operation —Write giving full particulars of academic qualifications and experience to Personnel Manager (L), Quaker Oats Limited, Bridge Road, Southall, Middlesex

---

TECHNICAL SALESMAN EXPERIENCED and qualified to develop chemical sales to vinyl resin manufacturers Interesting post good prospects Pension and profits-sharing schemes — Write full details age, qualifications experience to date, and salary required, to Ref TSP Box 8336 c/o Charles Barker & Sons Ltd , 31 Budge Row London, E C 4

GRADUATE CHEMIST, METALLURGIST or Chemical Engineer required to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel —Apply Electro-Chemical Engineering Co Ltd , 161 Queens Road Weybridge Surrey

---

SENIOR AND JUNIOR RESEARCH PHYSICISTS preferably with university or industrial research experience, are required to undertake basic research work of thermionic emission and related aspects of surface physics Wide scope and good prospects for men with initiative — Applicants should write to the Manager, Research Department, Metropolitan-Vickers Electrical Co Ltd , Trafford Park Manchester 17 giving particulars of their age qualifications and experience and suitable references

THE DISTILLERS COMPANY, LIMITED

A Physicist or Physical Chemist, interested in the mechanical and electrical properties of high polymers, is required at the Research and Development Department, Epsom, Surrey Duties would involve supervision of testing of a wide range of experimental plastics, fibres and rubbers, development of new test methods, and fundamental research or visco-elastic properties of polymers A good honours degree would be a minimum qualification, previous experience in the field mentioned, though desirable, is not essential This is a progressive post with excellent opportunities for the right person

Apply, Staff Manager, The Distillers Co, Ltd, 21 St James's Square London S W 1 Ref 10/55

MECHANICAL AND CHEMICAL ENGINEERS

Courtaulds, Limited Chemicals Division, requires two graduate Mechanical Engineers and one Chemical Engineer for investigational and development work near Manchester The work is of an original nature in connexion with the development of chemical plants and processes for which a real interest in, and potential talent for, engineering development work as applied to large-scale chemical plant is of paramount importance The Mechanical Engineers must have served an apprenticeship for at least two years, and all candidates must have had practical works experience Honours degree men preferred Age 25 to 35

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Limited, 16 St Martin's-le-Grand, London E C 1 quoting the reference number H8 for Mechanical Engineers and H 9 for the Chemical Engineer

---

SEVERAL WELL QUALIFIED INORGANIC or Physical Chemists wanted for a special group in the research organization of a majo chemical company Men are required with high technical initiative and sound knowledge who are interested in original and development work in inorganic and organo-metal fields At least one of the appointments will carry a salary of up to £1,500 per annum —Applications are invited giving comprehensive information as to age, background and experience to Box 646, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

PHYSICIST/MATHEMATICIAN TAYLOR, Taylor & Hobson, Ltd, require a man to specialize in the design and development of precision optical instruments He must be a skilled optical designer capable of tackling a wide range of problems and will work in close co-operation with the Mechanical Design Department A starting salary of not less than £800 per annum will be paid to a suitable candidate —Apply to Development Director, Stoughton Street Works Leicester

---

APLIN AND BARRETT, LTD YEOVIL Require a Senior Laboratory Steward for their Central Laboratories The Department includes routine and research laboratories carrying out chemical biochemical radiochemical and bacteriological work Some glass working experience would be an advantage Salary according to age and experience —Applications to Administrative Officer, Technical Department, Aplin and Barrett, Ltd Newton Road Yeovil Somerset

---

ASSISTANT WITH TECHNICAL QUALIFICATIONS required by Metropolitan-Vickers Electrical Co Ltd Trafford Park, Manchester, 17, to train as Industrial Information Officer Experience of this type of work is not essential Salary will depend on qualifications and experience and will be progressive —Write, giving full particulars, including age sex, nationality education and experience to Personnel Manager, marking envelope "H 2"

MULLARD RESEARCH LABORATORIES in Surrey have a number of vacancies for Physicists and Electronic Engineers with a good degree or equivalent qualification, for work in a variety of projects, including

(1) SOLID PHYSICS AND SEMICONDUCTORS

(2) MAGNETIC MATERIALS AND APPLICATIONS

(3) MICROWAVE TECHNIQUES

(4) ADVANCED ELECTRONIC CIRCUIT TECHNIQUES INCLUDING TRANSISTOR APPLICATIONS

(5) COLOUR TELEVISION

(6) COMPUTORS AND SERVO-MECHANISMS

Some years' experience in one or more of these fields is desirable, but recent and prospective graduates are also invited to apply Mathematics graduates with experimental leanings are not excluded

Successful applicants will join teams engaged on research and advanced development projects Publication of original work wherever possible is encouraged

Salaries are based on qualifications, experience and age, and are in keeping with present-day levels General prospects within the organization are excellent

Apply to Personnel Officer, MULLARD RESEARCH LABORATORIES, Cross Oak Lane, Salfords, near Redhill, Surrey, quoting reference E R L

ANALOGUE COMPUTORS AND INSTRUMENT servomechanisms Vacancy for an electronic Development Engineer, with experience in the above fields for work on interesting and varied projects Candidates should be of degree standard in physics or engineering, with some years' industrial experience Good prospects with progressive firm in Surrey area Write, giving full details of experience and salary required Ref S P D 2—Box 653 T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

DIVISIONAL SALES AND CONTRACTS Manager required for expanding medium-sized electronics company Applicants should be capable forthwith of initiating and negotiating development and manufacturing contracts in the electronic field and also at a later date establishing a sales organization for a commercial product Good opportunity for a man with initiative, prepared for hard work, and capable of earning £2,000 per annum Salary will include basic payment and commission by arrangement —Applications invited in confidence to Ref S P D 3 Box 654, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

CHEMISTRY AND ELECTRONICS A Scientist or Engineer, with good qualifications in one of these fields, and a strong interest in the other, is required to carry out development work on the application of electronic techniques to chemical analysis Good salary and prospects with progressive firm in Surrey area Write, giving full details of experience and salary required Ref S P D 1—Box 655, T G Scott and Son, Ltd, 143-147 Regent Street, London W 1

IMPERIAL CHEMICAL INDUSTRIES Limited, Paints Division, Slough, Bucks, has several vacancies for men aged 23 to 28 who have degrees in science or arts and who have a deep-rooted interest in the application of their training and abilities to commercial work Successful applicants may be required to spend a period of technical or practical training work in the Division, and will then be transferred to posts involving the sales service or distribution of a wide variety of industrial and decorative paints Experience of up to three years in some other industry would be no drawback and might be an advantage All posts would be pensionable —Apply, in writing, to Division Staff Officer, Imperial Chemical Industries Limited, Paints Division Wexham Road, Slough Bucks

---

MONSANTO CHEMICALS LIMITED HAV the following vacancies in the new research establishment at Newport, Mon Mechanical or Chemical Engineer for research work in the field o polymer technology Junior Physicist for researc in the field of polymer rheology and physics Fo both these posts a good honours degree is essential preferably with postgraduate research experience Good salaries, commensurate with experience, will be paid and there are excellent prospects —Applications, giving age, details of education, training and experience, should be sent t the Chief Personnel Officer, Monsanto Chemical Limited, 8 Waterloo Place, London, S W 1

GRANTS & SCHOLARSHIPS

UNIVERSITY OF LEEDS

DEPARTMENT OF COAL GAS AND FUEL INDUSTRIES WITH METALLURGY AND CHEMICAL ENGINEERING

Applications are invited from graduates we qualified in pure or applied science for Th Smith-K L G Research Scholarship for work o ceramic materials, particularly refractory oxides The Coal Tar Research Association Scholarsh for research on subjects connected with the coa tar industry, The Gas Research Fellowship provided by the Institution of Gas Engineers fo research in gas chemistry, and two posts of Research Assistant to the Joint Research Committe of the Gas Council and the university Industria experience will be an advantage, but is not esse tial The emoluments range from £325 to £60 a year

Further particulars in each case may be obtained from the Registrar, The University, Leeds 2, and detailed applications, giving the date o birth, qualifications, experience and the names o three referees should reach the Head of the Department of Coal Gas and Fuel Industries Th University, Leeds 2, not later than March 23 1955

SCHOLARSHIPS ABROAD, 1955–56

Applications are invited from British student for scholarships offered by Austria, Belgium Brazil, Denmark Egypt, Finland, France, Germany, Iceland, Italy, The Netherlands, Norway Persia, Portugal, Spain, Sweden, Switzerland an Yugoslavia The awards are mainly for university graduates and undergraduates and are tena for periods varying from a few weeks to twelv months during the academic year 1955-6 Th closing dates for receipt of applications vary fo each country, the earliest being March 7, 195

Full particulars and application forms, fo which a stamped addressed foolscap envelop should be sent, are obtainable from the Britis Council, 65 Davies Street, London, W 1, or fro any British Council office in the United Kingdo

---

BURSARIES OF £300 TO £400 PER ANNUM plus fees, for research on physical chemistry an metallurgy of metals, salts and silicates at hig temperatures with the Nuffield Research Grou in Extraction Metallurgy Imperial Colleg London S W 7 Work suitable for higher d gree Graduates in chemistry or metallurgy an those graduating this year, should apply now Dr Richardson

MISCELLANEOUS

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELOR and WIDOWERS of good character over 55 yea of age, who have done "something" in the w of promoting or helping some branch of Scienc

Donations or pensions may be granted persons who comply with these conditions

For particulars apply to MESSRS SHE HERD & WEDDERBURN, W S, 16 Charlo Square, Edinburgh 2

CONFERENCES FIRST-CLASS ACCOMM dation (single rooms) and catering, with amp lecture rooms etc, available September a Christmas, 1955, and Easter, 1956 Descript brochure —Apply Warden The College of Ae nautics, Cranfield Bletchley Bucks

---

TECHNICAL SERVICES BUREAU SPECIA izes in services to scientific and technical autho Preparing MS for press, indexing, proof-read translations secretarial work —17 Clifford Ro New Barnet, Herts BARnet 4730

ELECTRONICS APPLIED TO INDUSTR Learn the basic principles and applications w our modern self-study course Experimen work included if required —Free Brochure fr E M I Institutes Dept N 56 London W (Associated with H M V)

Colloidal MoS_2

The name of ACHESON COLLOIDS LIMITED has been associated, for over 50 years, with the manufacture of colloidal dispersions of graphite and other solids. Now to their well-known range of 'dag' dispersions, they add colloidal dispersions of molybdenum disulphide This outstanding new lubricant is being applied with great advantage to :—

Die forging, drawing, extrusion and cutting of metals,
Lubrication in operations involving high pressure and temperature,
Dry lubrication.

If you are interested in these new developments or in the various applications of our range of products our technical staff will gladly discuss them with you

dag
DISPERSIONS

of Colloidal Graphite, Molybdenum disulphide, metallic Silver, Titanium dioxide and other substances.

UNITS OF ACHESON INDUSTRIES

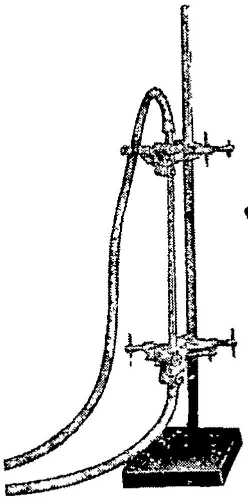
ACHESON COLLOIDS LIMITED
18 PALL MALL, LONDON, S.W 1
Telephone WHItehall 2034-7
Telegrams OILDAG, PICCY, LONDON
Also ACHESON COLLOIDS COMPANY
Port Huron, Michigan, U S A
Units of Acheson Industries

TAS/AC 57A

Measuring

Rate of flow

in research and industry



Type 100
Tube and float only, for laboratory use

FROM
Simple and accurate direct-reading Glass Tube Rotameters

Type 472
Industrial Rotameter for 8 in pipe Transmitting unit provides air signal to controller

TO .
Complete flow control equipment employing air-operated valve, power cylinder or electric motor speed regulator

Write for Catalogue RP2000/N which gives full details of the Rotameter range of flowmeters

ROTAMETER

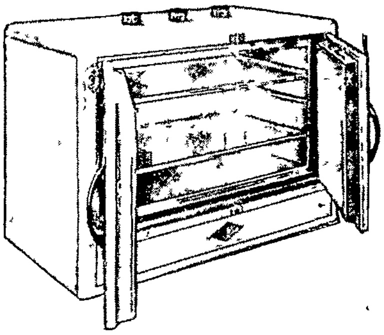
INSTRUMENTS FOR LIQUID AND GAS FLOW MEASUREMENT AND CONTROL

ROTAMETER MANUFACTURING COMPANY LIMITED
602 PURLEY WAY · CROYDON SURREY
Telephone CROydon 3816/9

DG/G15

LTE "CUSTOM BUILT"

Hot Air Oven and Steriliser

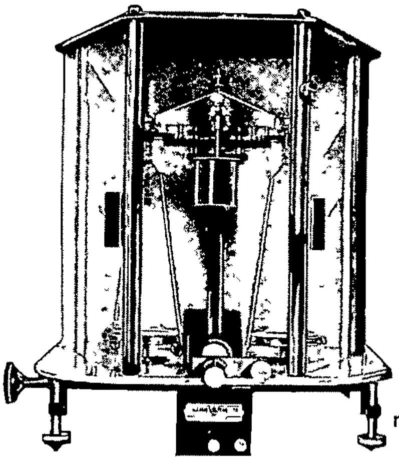


Other LTE Products—

Incubators
Universal Baths
Soxhlet Heaters
Thermostatic Baths
Dyepot Baths
Brewer's Mash Baths
"PATRA" Humidity Cabinet

Interior 36 in × 18 in × 18 in
Also stocked in 3 standard sizes which are available for one month on test approval.
Illustration on request to

LABORATORY THERMAL EQUIPMENT LTD
GREENFIELD, NR OLDHAM, ENGLAND
Telephone Saddleworth 552



The new Aperiodic Balance, using FLUID Damping

◆

Fast, Positive Settlement

◆

Metal case of modern design

Ask for particulars of the
"CRESTA I"
Aperiodic Balance.

Sole manufacturers
WILLIAM A. WEBB, LTD.
1-9 PERRYMANS FARM ROAD
NEWBURY PARK, ILFORD, ESSEX
who will gladly send details on request
Phone VALentine 6370
Grams Accuracy, Ilford
Cables Accuracy, Ilford

SINGER
Micromanipulators

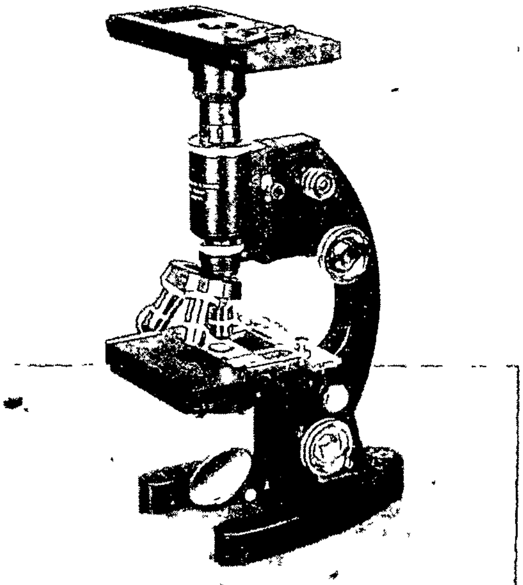
Singer (High-power) Micromanipulators are suitable for use under magnifications of from × 100 to × 1,000 diameters *plus*, as described by Barer and Saunders-Singer in the *Quarterly Journal of Microscopical Science*, Vol 89, pp 439-447, December, 1948.

Singer Microdissectors (Low-power Micromanipulators) are suitable for use under magnifications of from 1 to ×200 diameters and are described by Barer and Saunders-Singer in the *Journal of Scientific Instruments*, Vol 28, pp 65-68, March 1951

●

SINGER INSTRUMENT COMPANY LTD.
83, London Street, Reading

SINGLE EXPOSURE 35MM CAMERA



Cooke Troughton & Simms LTD
YORK ENGLAND

OVER 3,500 CHEMICALS IN THE EASTMAN RANGE

The new catalogue, No. 39, lists them all. Have you had your copy ?

We supply research chemicals and pilot scale amounts of special products not otherwise available in Great Britain We also supply bulk chemicals from Tennessee Eastman Co — Triethyl Phosphate, Butylated Hydroxyanisole, petroleum additives and others

Enquiries welcomed Write to

Kodak LIMITED
KIRKBY INDUSTRIAL ESTATE, LIVERPOOL

'Eastman' is a trade-mark

• Individually Tested and Guaranteed •
(A E R E Harwell approved)

HIGH VACUUM STOPCOCKS

New Catalogue on request to

G. SPRINGHAM & CO. Harlow New Town
"The Stopcock People" HARLOW 24108

◀ ◀ ◀ ◀ **GRATICULES**

We are now using so many modern methods of processing scales, masks and other graticules on glass that we can find a solution to most glass engraving and printing problems

PATON HAWKSLEY
ROCKHILL LABORATORIES, KEYNSHAM, SOMERSET
Offices 389 Archway Rd , London, N 6 KEYNSHAM 2364

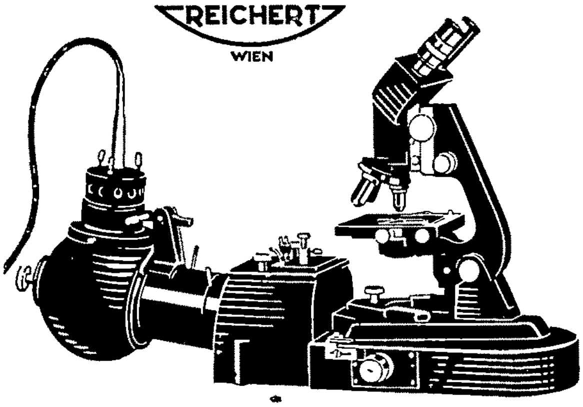
OPTICAL FLATS & PROOF PLATES

Your requirements may be listed in our Lens and Prism Leaflet but, if not, we would be glad to quote for making to specification

Our illustrated leaflets are available on request. Listed are many Second-Hand and Ex-Government items of Photographic, Optical and Scientific interest

CHARLES FRANK
Instrument Makers and Dealers since 1907
67/73, SALTMARKET, GLASGOW, C.I
Phone Bell 2106 and 2107

FLUORESCENCE MICROSCOPY



. . . how to apply it and where to find references

Very few microscopists in English-speaking countries have been able to avail themselves of the many advantages of fluorescence microscopy, due to the lack of detailed information and references. The Reichert Works of Vienna, who pioneered micro fluorescence equipment, have now published two booklets invaluable to everyone engaged in or contemplating the use of fluorescence microscopy :

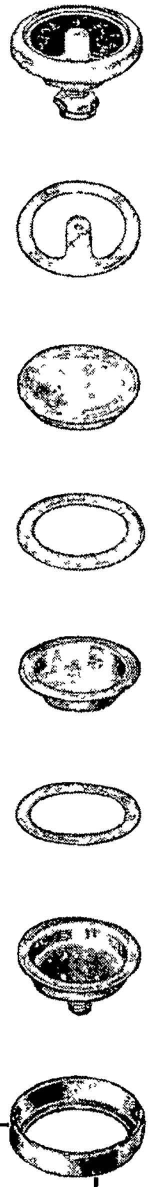
(1) *Fluorescence Microscopy with Fluorochromes*, containing 30 pages of detailed instructions for the preparation and staining of human, animal, and plant tissues and bacteriological material.

(2) *Literatur zur Fluoreszenz Mikroskopie*, containing 52 pages of cross-indexed references to books and papers published on this subject.

Copies of these two publications and full information on Reichert Fluorescence Equipment—which incidentally can be used with any existing microscope—are available free of charge on request We shall also be delighted to demonstrate the fluorescence microscope at the address given below—Please telephone us for an appointment

SHANDON

SHANDON SCIENTIFIC COMPANY LTD.
6, CROMWELL PLACE, LONDON, S W7 Tel· KNI 1131



The case for 'Castanet'...

The problems of obtaining satisfactory time constants and at the same time keeping component bulk down to a minimum are all too familiar These polarised miniature electrolytic capacitors —CASTANET by name—go all the way in removing what has for a long time been a thorn in the side of designers A mere 22 mm by 6 mm, with a capacity of 50 microfarads and a D C leakage of less than one microamp at 70V , CASTANET capacitors are capable of operating over a temperature range of—60° C to + 150° C After shelf storage, without volts, at 70°C for several thousand hours, the capacity, power factor and D.C leakage current values show no significant change

The place for 'Castanet'...

The determination of the place for CASTANET is simple It is anywhere where space is at a premium and essential characteristics demand stability of performance coupled with low leakage current over a very wide temperature range The units are normally provided with a 4 BA stud and anode tag A silicone rubber grommet is available by means of which the units can be mounted on a chassis and connected in series or parallel, providing a range of working voltages and capacities

Time constants of the order of one hour can be obtained making the units ideal for very long period discharge circuitry, in addition to the more conventional applications

Plessey

'Castanet'

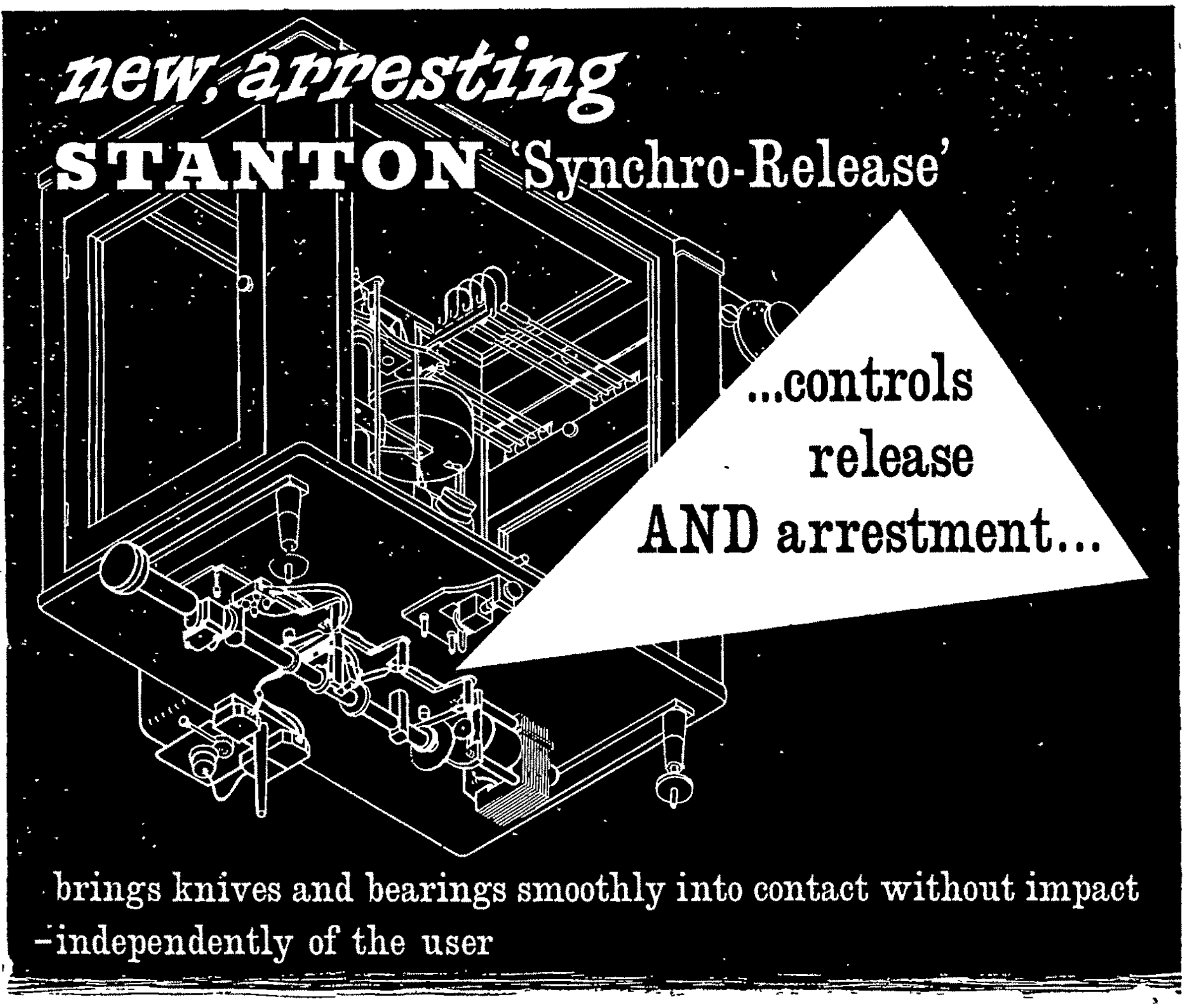
REGD TRADE MARK

Tantalum Electrolytic Capacitors

Manufacturers are invited to write for Plessey Publication No 659/1 which contains comprehensive details of the product

'Castanet' Electrolytic Capacitors are produced by the Chemical & Metallurgical Division of The Plessey Co Ltd , Wood Burcote Way, Towcester, Northants

PC 1b


new, arresting
STANTON 'Synchro-Release'
...controls release AND arrestment...
brings knives and bearings smoothly into contact without impact
–independently of the user

The most careful chemist could not release a balance more smoothly than the Stanton "Synchro-Release" device So gently controlled is the automatic motion of the "Synchro-Release" mechanism that knife edges and bearings are brought into contact swiftly, safely, accurately, without the slightest jarring or vibration of impact no matter how hurried or unskilled the operator may be

ALL Stanton balances can now be supplied with "Synchro-Release" giving these extra advantages —

- **Safely controls arrestment as well as release.**
- **No loss in weighing time**
- **Ensures sustained accuracy on routine weighings.**
- **Simple, sturdy synchronous device—nothing to go wrong.**
- **Facilitates training of laboratory personnel.**
- **Reduces balance operating costs**

SEND TO-DAY *for illustrated leaflet giving full details of this amazing new improvement*

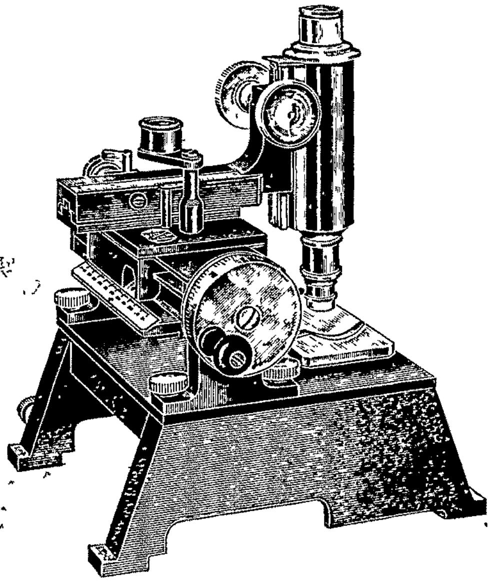
STANTON
precision balances

Please send me a free copy of "Contact without Impact"
Stanton Instruments Ltd, (Dept N 4
119 Oxford Street, London, W 1
Name
Address

BECK

MICROMETER MICROSCOPE

Accuracy in measurement



Full particulars of:

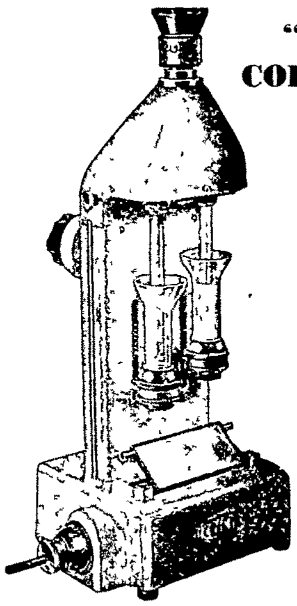
R & J BECK LTD • 69/71 MORTIMER STREET LONDON, W 1

HAWKSLEY

"CRISTA" COLORIMETER

With macro- and micro-cups and plungers

Particulars on request



HAWKSLEY & SONS Ltd.

17 NEW CAVENDISH ST., LONDON, W.1

Telephone WELbeck 3859 Telegrams "Diffract, Wesdo, London"

GREEN'S PURE FILTER PAPERS

◆

Write for "Signposts to Better Filtration", a most useful and interesting booklet

◆

Sole and original makers:

J. BARCHAM GREEN LTD.

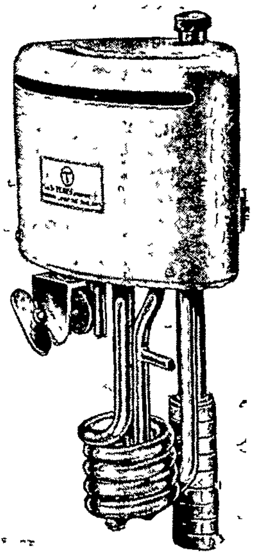
Maidstone • England

THE TECHNE TEMPUNIT

This self contained constant temperature control unit has been widely sold and in its new form has features that place it in a class by itself The unique pneumatic control system has all the sensitivity of electrical contact methods with far greater dependability and longevity

Control is ± 0.5°C

Range from room temperature to 96°C



For full details write to:

TECHNE (CAMBRIDGE) LTD DUXFORD CAMBRIDGE ENGLANI

Printed in Great Britain by FISHER, KNIGHT & Co, LTD, The Gainsborough Press, St Albans, and published by MACMILLAN & Co, LIMITED, at St Martin's Street, London, W C 2, and ST. MARTIN'S PRESS, INC, 103 Park Avenue, New York 17, N Y, U S A —Saturday, February 26, 1955

NATURE

'To the solid ground
Of nature trusts the Mind that builds for aye"—Wordsworth

VOL. 175, No. 4453 SATURDAY, MARCH 5, 1955 TWO SHILLINGS

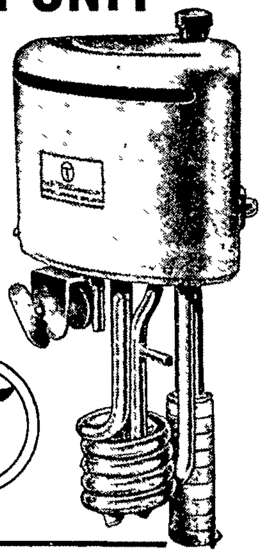
LIBRARY

TECHNE TEMPUNIT

This self contained constant temperature control unit has been widely sold and in its new form has features that place it in a class by itself The unique pneumatic control system has all the sensitivity of electrical contact methods with far greater dependability and longevity

Control is ± .05°C
Range from room temperature to 96°C

TECHNE (CAMBRIDGE) LTD
DUXFORD CAMBRIDGE ENGLAND



For Ultra-violet absorption research

Vitreosil Spectrophotometer Cells are made from specially selected transparent fused quartz, which has a high efficiency in the Ultra-violet range. The Cells have fused joints and are available in a standard range of sizes suitable for most spectrophotometer equipment. The standard sizes of Vitreosil Cells can be supplied matched if required

VITREOSIL PURE FUSED QUARTZ
SPECTROPHOTOMETER CELLS

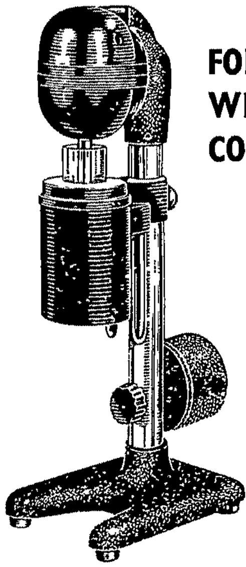
THE THERMAL SYNDICATE LTD.
Wallsend, Northumberland (Telephone: Wallsend 63242
London: 12-14 Old Pye Street, Westminster, S W 1

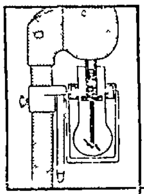
MSE *Homogeniser*

The most versatile laboratory mixer made. It takes three different types and sizes of container enabling it to handle quantities from 100 c.c. down to 3 c.c. Speed is infinitely variable up to 14,000 r p.m. The housing for the 100 c c. and 10 c.c. containers can be filled with dry ice or other convenient coolant, providing effective counter-action to the temperature rise normally met in high-speed blending.

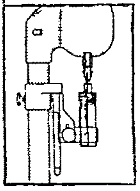
MSE Publication No. 131

FOR 3ml. to 100ml. WITH TEMPERATURE CONTROL FACILITY



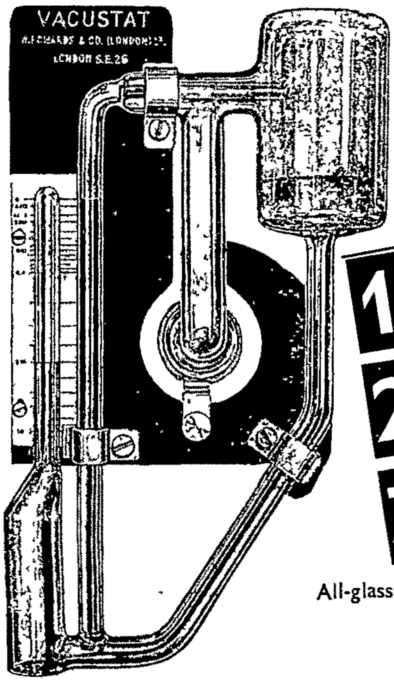


Cross-section showing how the 100 c c beaker is accommodated in the plastic container, providing space for coolant.



Universal Container Attachment for quantities down to 3 c c

MEASURING & SCIENTIFIC EQUIPMENT LTD., SPENSER STREET, LONDON, S W.1



A 9 inch McLEOD-TYPE VACUUM GAUGE

– just swivel to operate !

1 **ANTI-PARALLAX SCALE** for easier reading

2 **NEW DESIGN BACKING PLATE** with plastic cover ensuring fully protected glasswork (bench model)

3 **UNIQUE ROTATING 'O' RING SEAL** Eliminates inconvenience of rubber tubing

★ **MODELS AVAILABLE**

- **BENCH** Only 9″ high ideal for general work
- **INDUSTRIAL ENCLOSED** For permanent panel mounting into apparatus
- **ALL-GLASS** For direct fusion to glass apparatus

All-glass Model

Where the standard McLeod gauge is inconvenient for the measuring of high vacuum, we supply the 'VACUSTAT'—a miniature bench McLeod standing only 9 in high This gauge has proved very successful for laboratory and industrial applications and is now available in forms suitable for permanent installation into production plant and for direct cone mounting into all-glass systems
RANGES 10 0 to 0 01 and 1 0 to 0 001 mm Hg

W. EDWARDS & CO (LONDON) LTD *for better vacuum service*

MANOR ROYAL CRAWLEY SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

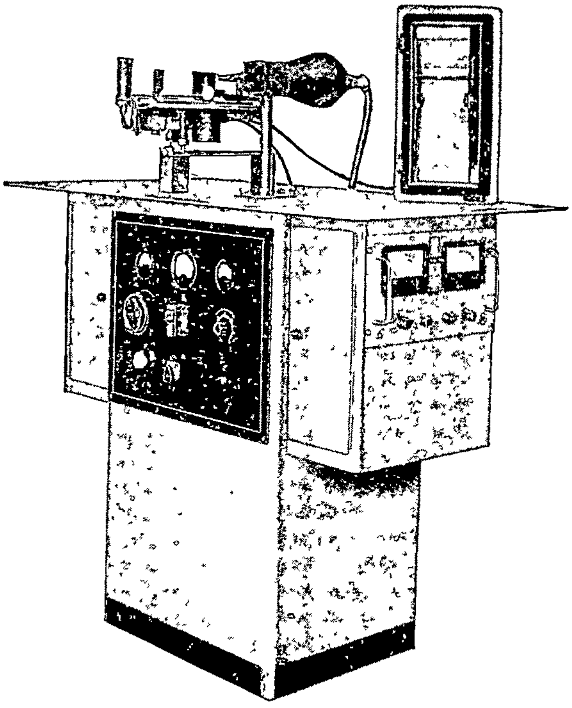
X-RAY

Crystallography

Complete self-contained unit comprising .
High Voltage Generator and controls
Shockproof tube
Berthold Spectrometer with Geiger Counter
Ratemeter
Recorder
Cabinet and work bench

Particulars on request

SOLUS-SCHALL LIMITED
18 NEW CAVENDISH STREET
LONDON, W 1



CASELLA ELECTRONICS

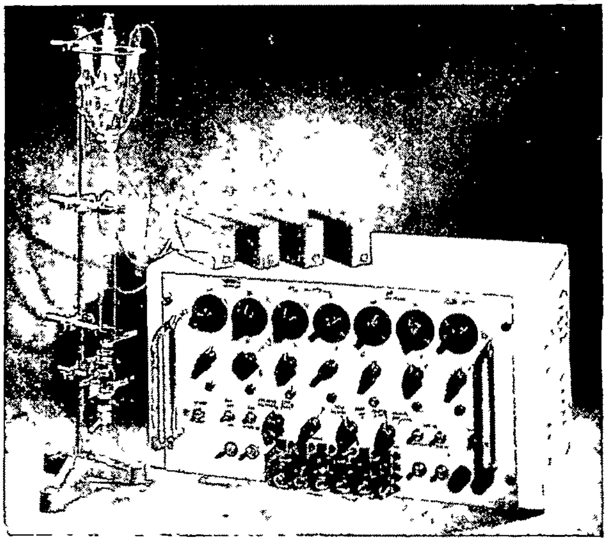
AN
AUTOMATIC BIOLOGICAL ASSAY APPARATUS

for the quantitative measurement of the activity of drugs

This new apparatus greatly improves the accuracy, speed and convenience of measurements made on isolated organs and by being fully automatic releases skilled, highly paid technicians for other work. Typical examples of its use are:

1. Standard assay of posterior extract on guinea pig uterus
2. Test of activity of an antispasmodic drug on rabbit intestine.
3. Four point assay of histamine on guinea pig ileum

CASELLA (ELECTRONICS) LTD.
46/48 OSNABURGH STREET
LONDON, N.W.1
Telephone EUSton 8144



DORAN

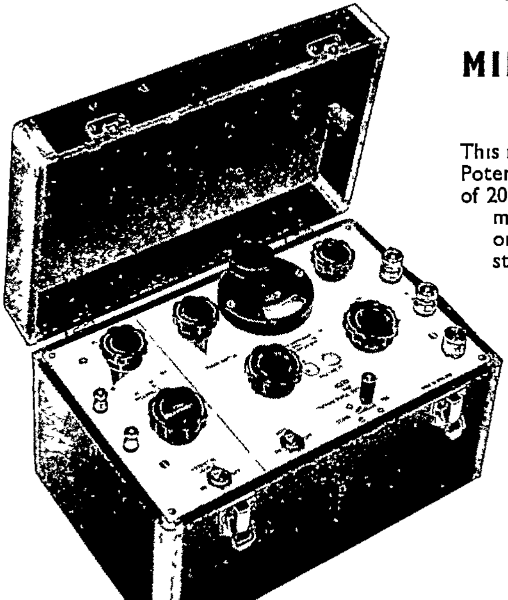
MINI THERMO-COUPLE POTENTIOMETER
CAT. NO. E4229

This instrument is a development of the standard Mini Thermo-couple Potentiometer which is fully described in List 112. It has two ranges of 20 and 100 millivolts and is direct reading to 10 microvolts and 50 microvolts respectively, each of these values being represented by one division on the slide wire dial. The potentiometer circuit is standardised against a Weston Normal Cell and the Potentiometer current is derived from a 1·5 volt dry cell fitted internally. To enable the instrument to be employed for the checking of thermo-electric indicators and recorders, an additional unit, usually known as a potential source, is provided, which gives an adjustable e.m.f from 0–100 millivolts—which is applied to the instrument under test. The Potentiometer itself then measures the e.m.f. required to deflect the indicator or recorder to any particular point on the scale. The instrument is self-contained and is very compact.

SPECIFICATION.
Range: 20 and 100 millivolts
Weight: 9¾ lb.
Dimensions: 11 in. × 7 in. × 5¾ in.

DORAN INSTRUMENT CO. LTD.
STROUD, GLOS.

Telephone
STROUD 462
and 15



WHATMAN
FILTER PAPER

The Whatman range covers
all requirements of the chemist in every
branch of industry and research

Filtration:—

QUALITATIVE GRADES
QUANTITATIVE GRADES
HARDENED GRADES

Specialities:—

ASHLESS TABLETS & FLOC
ANTIBIOTIC ASSAY DISCS
EXTRACTION THIMBLES

Cellulose Powders for:—

CHROMATOGRAPHY

Papers for.—

CHROMATOGRAPHY AND ELECTROPHORESIS

◆

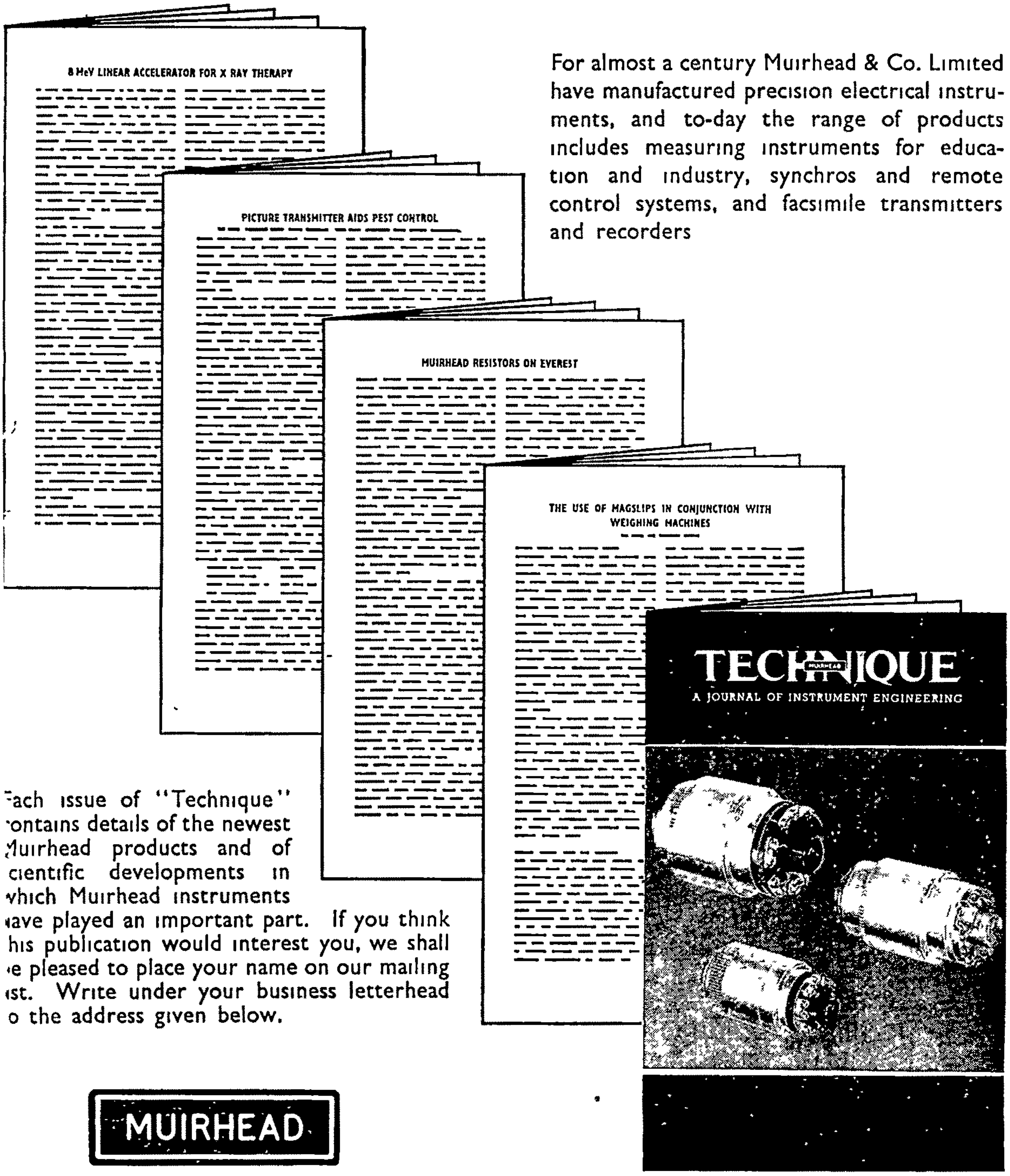
Supplies may be obtained through all regular Whatman suppliers

◆

Sole Mill Representatives —
H. REEVE ANGEL & CO., LTD.
9 Bridewell Place, London, E C 4

Manufacturers —
W. & R. BALSTON, LTD., MAIDSTONE, KENT

THIS INTERESTING QUARTERLY WILL BE MAILED FREE TO ANY PART OF THE WORLD


8 MeV LINEAR ACCELERATOR FOR X RAY THERAPY
PICTURE TRANSMITTER AIDS PEST CONTROL
MUIRHEAD RESISTORS ON EVEREST
THE USE OF MAGSLIPS IN CONJUNCTION WITH WEIGHING MACHINES
TECHNIQUE
A JOURNAL OF INSTRUMENT ENGINEERING

For almost a century Muirhead & Co. Limited have manufactured precision electrical instruments, and to-day the range of products includes measuring instruments for education and industry, synchros and remote control systems, and facsimile transmitters and recorders

Each issue of "Technique" contains details of the newest Muirhead products and of cientific developments in which Muirhead instruments have played an important part. If you think his publication would interest you, we shall be pleased to place your name on our mailing list. Write under your business letterhead o the address given below.

MUIRHEAD

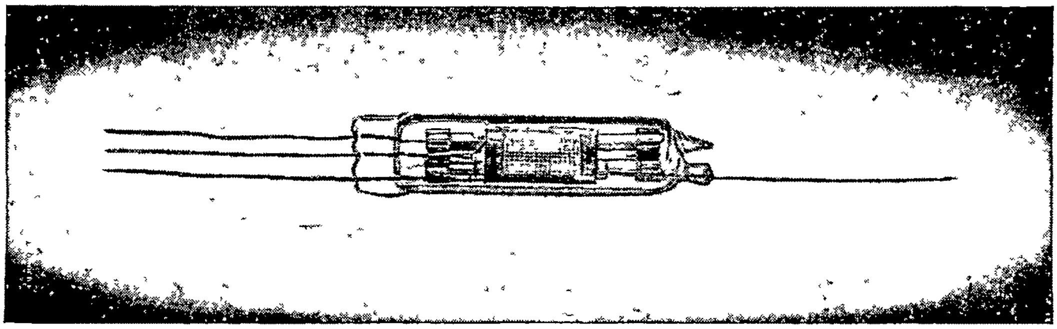
PRECISION ELECTRICAL INSTRUMENTS

133

MUIRHEAD & CO. LIMITED • BECKENHAM • KENT • ENGLAND

G.E.C.

electronics



ET3

sub-miniature

ELECTROMETER

TRIODE

The ET3 is of special interest where an electrometer valve of small dimensions is required as in portable equipment. The flexible leads render a valve holder unnecessary and the low filament rating of 1·25V, 25mA permits the valve to be run entirely from small dry cells.

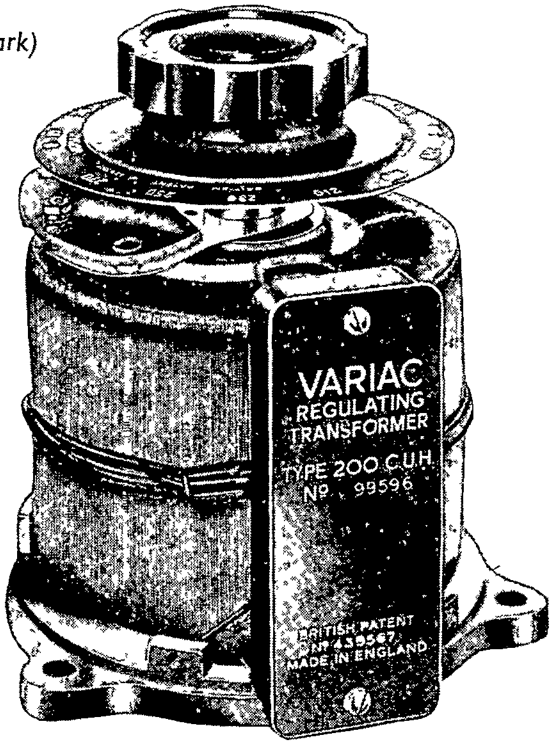
The input resistance is greater than 10^{14} ohms and a water repellent coating is applied to the glass envelope which virtually eliminates condensation in conditions of high humidity.

Full technical information may be obtained on application from The Osram Valve & Electronics Department.

THE GENERAL ELECTRIC CO LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

"VARIAC"

(Reg'd Trade Mark)



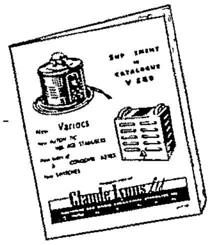
INFINITELY VARIABLE

auto transformers

The "VARIAC" is the original, continuously adjustable auto-transformer the ideal control for varying the a-c voltage applied to any electrical, electronic, radar or communications equipment Voltages from Zero to 17% above line are obtained by a 320-degree rotation of the shaft, which is equipped with a direct-reading dial, calibrated accurately

"VARIAC" offers many real advantages over any other type of a-c control compared with the losses of resistive controls they save their initial cost within about one year They are available in various sizes from 170 VA up to 25 Kilowatts 3-gang assemblies are also available for 3-phase working Prices vary from £7 10 0 upwards

Write for our Catalogue—Technical Manual V 549, which gives all possible information



Request also our 20-page Supplementary Catalogue giving complete information on our new and complete range of A C Automatic Voltage Stabilisers These range from 200 VA to 25 kVA Performance is excellent, from No-Load to Full Load, and stability is quite unaffected by frequency variations Prices are exceptionally low

CLAUDE LYONS LTD.

ELECTRICAL AND RADIO
LABORATORY APPARATUS ETC.
Head Office and Works . 76, Oldhall St,
Liverpool 3, Lancs.
Southern Factory : Valley Works, Ware
Road, Hoddesdon, Herts
(A.10 main London/Cambridge Road at
Junction of A 602)

Claude Lyons Ltd are exclusive distributors of GENERAL RADIO equipment in this country If you require information about their extensive range of instruments please tick appropriate square(s)

SOUND MEASURING AND ANALYSING EQUIPMENT ☐
STANDARDS OF RESISTANCE, CAPACITANCE AND INDUCTANCE ☐
BRIDGES OF ALL TYPES ☐
OSCILLATORS AND AMPLIFIERS ☐
STANDARD-SIGNAL GENERATORS ☐

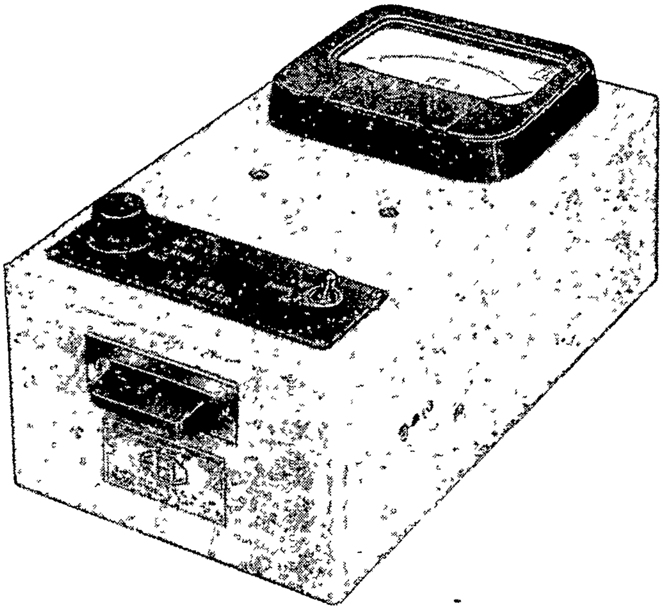
WAVEFORM-MEASURING APPARATUS ☐
FREQUENCY-MEASURING EQUIPMENT ☐
RADIO AND T V STATION MONITORS ☐
LABORATORY METERS OF ALL TYPES ☐

Name

Address

Employer

Position



The "EEL" H_2S METER

This is a robust, accurate instrument for the rapid assessment of lead sulphide stains. It can be operated by unskilled personnel for the routine examination of hydrogen sulphide in town gas, which is an essential feature in the control of gas purification.

Full details of this and other photoelectric instruments and photocells sent with pleasure

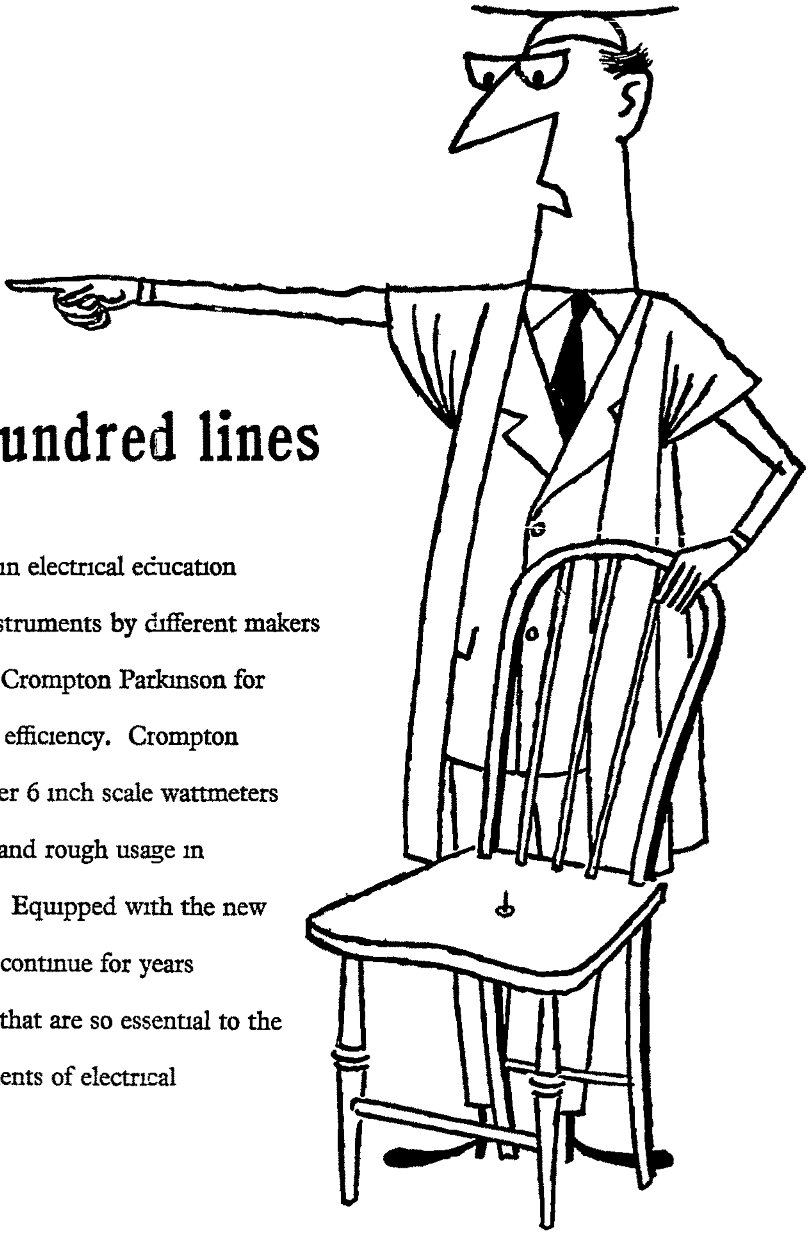
THE PRODUCTS OF

EVANS ELECTROSELENIUM LTD

SALES DIVISION 25 HARLOW ESSEX

Representatives for sales and service

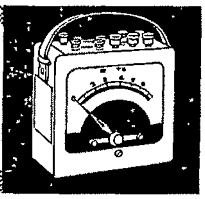
Manchester area —Messrs A M Lock & Co, Ltd, Crompton Street, Chadderton, Lancs
North of England —Messrs Electricals, Ltd., 14 Claremont Place, Newcastle-upon-Tyne, 2
Scotland —Messrs Atkins Robertson & Whiteford, Ltd, 92–100 Torrisdale Street, Glasgow, S 2



Take a hundred lines

Take a hundred different lines in electrical education equipment. Take a score of instruments by different makers —you will find it hard to beat Crompton Parkinson for accuracy, reliability and lasting efficiency. Crompton Parkinson portable dynamometer 6 inch scale wattmeters are specially designed to withstand rough usage in school and college laboratories. Equipped with the new sprung jewel bearing, they will continue for years to give those accurate readings that are so essential to the student when learning the elements of electrical theory and practice.

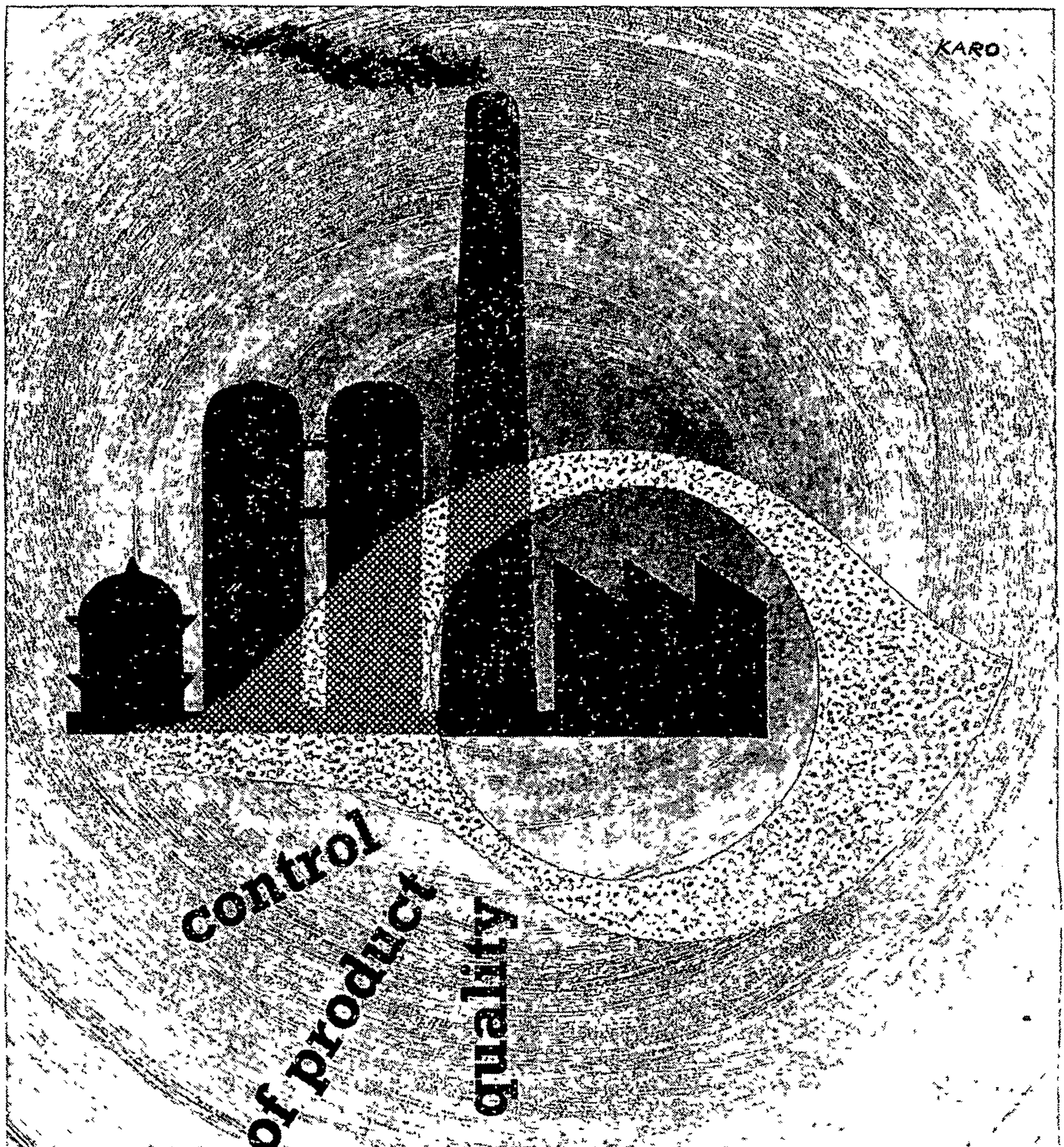
Crompton Parkinson LIMITED



ELECTRICAL EQUIPMENT

A good name for Electrical Instruments

CROMPTON PARKINSON LTD CROMPTON HOUSE ALDWYCH LONDON WC2 TEL CHANCERY 3333



New products and new processes are
the outcome of continuous research. It follows
that the tools of research are applicable to process control.
The Spectrophotometer, widely used in research
laboratories for ultraviolet, visible and infrared investigations,
is the ideal instrument for routine analysis and control of product quality.

Chemists who need to keep an eye on things
are invited to write for details to
Unicam Instruments of Cambridge.

UNICAM
SPECTROPHOTOMETERS

NATURE

No. 4453 SATURDAY, MARCH 5, 1955 Vol. 175

CONTENTS

	page
Air Pollution	399
Chemical Constitution By Prof M J S Dewar	400
Biochemistry for Medical Students By Prof D C Harrison	400
A Philosophical Treasure-Hunt By Dr C K Grant	401
A Text-book of Embryology By Prof W J Hamilton	401
Scientific Programme of the International Geophysical Year 1957–58 By Prof Sydney Chapman, F R S	402
A Pattern for Industrial Research	406
Obituaries.	
Miss M S Johnston By Dr H Dighton Thomas	409
Mr Eric Parker By R. N Rose	409
News and Views	410
Co-operation in Engineering Research between Educational Institutions and Industry	413
Airflow over Mountains By G A Corby	414
The British Council Annual Report	415
Physiology of Stomata	417
An Experiment on the Inhibition of Thermal Convection by a Magnetic Field By Dr Yoshinari Nakagawa	417
Structure of the Isomeric 2 4-Dinitrophenylhydrazones of some Alpha-keto-acids in Relation to their Infra-red Spectra By Dr F A Isherwood and R Lumley Jones	419
Letters to the Editors	
Gas-Phase Chromatography —Dr A E Martin and J Smart	422
Permanent Dissociation of Sulphur Hexafluoride in Corona Discharges —Robert Thorburn	423
A Molecular Approach to the Problem of Viscoelasticity —Prof Alfred H Nissan	424
Infra-red Absorption Spectrum of Fluoropyruvic Acid —L C Thomas	424
Formation of Aquo Ions —Dr Leonard I Katzin and Elizabeth Gebert, Dr Christian Klixbull Jørgensen and Prof. Jannik Bjerrum	425
Ranges of Low-Energy Electrons in Protein —Marguerite Davis	427
Effect of Oxygen on the Radiosensitivity of Growing Bone and a Possible Danger in the Use of Oxygen during Radiotherapy —P Howard-Flanders and E A Wright	428
Relation of Magnesium Supply to Growth and Net Assimilation-rate in Barley —T. F. Neales	429
Occurrence of the Root-knot Eelworm, *Meloidogyne hapla*, out of doors in Great Britain —E B Brown	430
Witchweed and Soil Fertility —J J Basinski	431
A Nematode Parasite of *Drosophila* —E B Basden and J B Goodey	431
A Method of isolating Vesicular Arbuscular Endophytes from Roots —R W Harrison	432
Embryo Development in Areca-nut —Dr C Venkata Rao	432
The Vector of an Outbreak of Kala-Azar in Kenya —Dr R B Heisch	433
A Primary Skin Lesion in Visceral Leishmaniasis —Dr P E C Manson-Bahr	433
Use of Propylene Phenoxetol as a Relaxing Agent —G Owen	434
Observations on a Human Tumour in Tissue Culture —Dr Audrey Fjelde	434
Biosynthesis of Hyaluronate —D A Lowther and H J Rogers	435
Utilization of Sulphate Ion by Fibroblasts in the Quartz Focus —R C Curran and J S Kennedy	435
"Animal Cytology and Evolution "—Prof C H Waddington, F R S, and Prof H G Callan	436
"Independence in Publication "—Dr L Harrison Matthews, F R S	436

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number: Whitehall 8831 Telegrams Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T G. Scott & Son, Ltd , Crown House, 143–147 Regent Street, London, W.1
Telephone Number · Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

DIFCO

Detection of

COLI IN WATER

This group of Difco Dehydrated Culture Media is recommended for the detection and confirmation of the presence of coliform bacteria in water. Each medium is prepared to conform to all requirements of "Standard Methods for the Examination of Water and Sewage" of the A.P.H.A and A W W A.

Bacto-Lactose Broth
Bacto-Endo Agar
Bacto-Levine E.M.B. Agar
Bacto-Brilliant Green Bile 2%
Bacto-Formate Ricinoleate Broth
Bacto-Lauryl Tryptose Broth

Specify "DIFCO"
THE TRADE NAME OF THE PIONEERS
in the Research and Development of Bacto-Peptone and Dehydrated Culture Media

Sole Agents for Great Britain

BAIRD & TATLOCK (LONDON) LTD.
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?
Suppliers to all Leading Universities, Public Libraries and Institutions of the World
Catalogues issued.

★

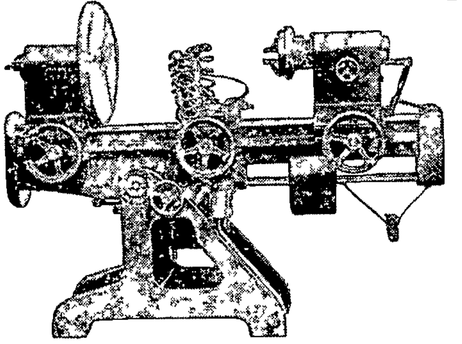
SELLING?
Specialists in Scientific, Technical Books and Publications of all Learned Societies

★

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephone. Wel. 7948, *Amb.* 5991

Universal Glass Working Lathe Mounted Horizontally



This machine can be raised into the vertical position in the matter of a few moments.
There are five models to choose from. May we send you leaflets?

Heathway
Machinery Co., Ltd.
Uxbridge Road, Hillingdon, Middlesex.
Telephone: Uxbridge 6345.

AIR POLLUTION

THE results of a painstaking examination of the problem of air pollution, to which the attention of the public was acutely aroused by the lamentable consequences of the London fog of December 1950, appears in the recently issued report of the Committee on Air Pollution, presided over by Sir Hugh Beaver*. The published report is crowded from cover to cover with the results of detailed investigations of the manifold aspects of the problems encountered, and therein is set forth a series of recommendations, aptly defined as a clean air policy.

Legislation is called for to strengthen the law with regard to the abatement of atmospheric pollution. Quite a number of additional recommendations cover important aspects of public policy, which will command general acceptance, indeed, they are the logical development of efforts to improve the situation that have been prosecuted steadily for many years. Foremost among these more beneficent influences has been the general impact of research and engineering development on the design and use of combustion appliances in both the industrial and the domestic fields. The responsibility for atmospheric pollution is shown to fall about equally in these two spheres The most difficult problem is the domestic one The Committee considers that it is the cumulative effect of light smoke from a number of low chimneys that really matters, and the legislative provision recommended entails the institution of smokeless zones and smoke-control areas A snag arises in the proposal that the Exchequer and the local authority are to contribute jointly towards the cost of converting domestic appliances in these areas. The installation of appliances of improved types for the main domestic space- and water-heating services is to be made compulsory in the case of new premises. Much higher penalties are to be invoked for the enforcement of the law of pollution abatement The power-stations that burn pulverized fuel in any form beyond a rate of ten tons per hour are to instal efficient dust- and grit-arresting equipment. Cement kilns are apparently not to be subjected to this control, on the grounds of the greater technical difficulties involved, although it is well known by the public that some of the most pleasant beauty spots are plagued by this nuisance It could have been wished that there had been a more incisive and courageous recommendation on this issue

The question of sulphur pollution has been closely examined, and some of the possibilities indicated, but the value of a national policy of total gasification has been overlooked. It is true to say that more research effort in this direction is needed for a satisfactory process to be developed, but it is clear that the most effective means of removing sulphur, and indeed of recovering it in a useful form, is through gas purification. Though coke has many advantages as a means of domestic heating, it must be emphasized that the reserves of coking coal are limited. So far as coal is concerned, the larger reserves of less satisfactorily coking coals must be sooner or later brought into the picture

Railway smoke comes in for strong condemnation, since more than one-seventh of the smoke discharged to the atmosphere comes from this source The answer which is in line with the Committee's recommendations has been given by the proposals of the Transport Commission for the future development of British railways by the substitution of the steam locomotive by electrification and the most convenient form of diesel-engine traction. An unexpected situation arises in respect of motor-vehicle exhausts, which can be a serious menace. The present law is explicit and believed to be adequate, but the Committee could not find that it was, in fact, enforced

There is a strong call for the use of smokeless fuels in the so-called 'black areas', and doubtless the development of this remedy will be followed as ways and means become available. To stimulate the use of gas and electricity, the removal of purchase tax on appliances is urged.

As to the precise measures to be taken to put into effect the very desirable requirements foreshadowed, the Government has already indicated by a recent announcement in the House of Commons that it has recognized that the key to the domestic smoke problem lies in the displacement of obsolescent equipment by more efficient types, and that the extension of smokeless zones must be made practicable by assistance in purchasing modern types from central or local government funds

In the application of the many other recommendations of the Committee, it is hoped that there will not occur a possible danger of the confusion of the technical and administrative functions in putting the appropriate measures into action. This danger has long been a national failing, in regard to which technical opinion has not always been so forceful, or even active at all, in the right quarters as it should be Initiative for certain technical measures is placed at the door of the British Standards Institution, when it should be more properly found in the board rooms and laboratories of the expert technical institutions, which must provide the pertinent bases for the specifications required.

The well-worn demand that stoking should be regarded as a skilled operation is repeated. One may only hope that the simile of water wearing away the stone will be here applicable

Twelve appendixes of both technical value and public interest have been provided. Finally, a list of some hundred and thirty authorities that have been consulted are listed There must have been numerous other individuals also consulted The evidence is thus abundant that Sir Hugh Beaver and his Committee have laboured very hard in the public interest, and it is to be hoped that the response of the authorities concerned will be effective and prompt

---

* Committee on Air Pollution Report Pp 80 (Cmd 9322 (London H M Stationery Office, 1954) 3s net

CHEMICAL CONSTITUTION

Chemical Constitution

An Introduction to the Theory of the Chemical Bond. By Prof. Dr. J A. A. Ketelaar Pp. viii+398 (Amsterdam and New York: Elsevier Publishing Company, Inc., London. Cleaver-Hume Press, Ltd., 1953) 40*s*.

CHEMISTRY has been revolutionized in the past thirty years by the development of quantum theory, and by the fresh insight the theory gave into problems of atomic and molecular structure The new ideas spread rapidly under the influence of several notable monographs In recent years, however, a growing rift has separated the theoreticians from chemists in general, largely because the more recent developments have not been adequately described in simple terms in book form, and the lack of text-books has also hindered the teaching of theoretical chemistry. Prof J A A Ketelaar's book is an attempt to fill this gap: it is described as "an introduction to the theory of the chemical bond" and is clearly intended for the general reader.

The book falls into five sections First, an introductory section on the Periodic Table, the basic ideas of wave mechanics and the types of chemical bond, next, a section on ionic compounds treated from the classical point of view, next, a section on the covalent bond, beginning with the quantum mechanical treatment of covalency and the structures of simple molecules, and continuing with a discussion, in terms of resonance theory, of complex molecules and of such topics as conjugation, bond properties, chemical reactivity and colour, next, a short section on metals, and finally, a section on van der Waals forces and the hydrogen bond There are bibliographies at the ends of sections, but few references.

The intention and general plan of the book are excellent, but unfortunately the execution leaves much to be desired. First, the more elementary sections are too condensed to be intelligible to a reader who needed them, this criticism applies to the whole of the first section, to the quantum mechanical treatment of covalency in the third section, and to the section on metals The situation is made worse by the introduction of irrelevant complications (for example, pp. 9–10) and by an approach sufficiently mathematical to intimidate the uninitiated reader but totally inadequate as an introduction to the detailed mathematical theory. Secondly, the book is very badly constructed. Throughout the text there are numerous references to later sections, new ideas are introduced without explanation (for example, the table on p. 20, dipoles on p 72, the Planck and Einstein relations on p 107, the Bohr atom on p 109, overlap on p 149, bond character on pp 175, 186), and when new ideas are introduced they are often not treated coherently in one place (for example, *s-p* hybridization is discussed in detail on pp 153–54, but dsp^2 hybridization is mentioned without explanation on p 173) Thirdly, the segregation of ionic and covalent compounds has its drawbacks, typical covalent compounds are discussed as though they were ionic in the second section (pp 54, 55, 60), and the relation between ionic and covalent bonds is nowhere adequately discussed.

There are various small errors and omissions. For example it is implied incorrectly on p. 152 that a linear combination of non-degenerate solutions of a wave equation is itself a solution, the inductive effect is wrongly described on p 221, the explanation for the instability of vinyl alcohol on p. 222 is incorrect, and on p 239 the author has overlooked recent work on Tschitschibabin's hydrocarbon

The general impression is of a book written without adequate planning or integration and consequently too obscure for the uninitiated reader. A reader familiar with the field will find much to interest him although he may feel the lack of adequate references Most of the references are to papers dealing in detail with advanced and irrelevant topics (for example, nuclear resonance, p. 199)

The book is very well produced and pleasantly free from misprints. The price is very reasonable.

M. J S. DEWAR

BIOCHEMISTRY FOR MEDICAL STUDENTS

Biochemistry

By Prof. Abraham Cantarow and Dr Bernard Schepartz. Pp xxv+848. (Philadelphia and London: W. B. Saunders Company, 1954.) 55*s*.

THIS is designed primarily as a text-book for medical students, but it is doubtful whether as such it will have much appeal in Britain In most British universities, the departments of anatomy and physiology and biochemistry compete keenly for the student's time, and as things work out the medical student simply has not the time to deal with biochemistry in anything like the detail in which it is presented in this 800-page volume. If he attempts to do so he is likely to miss the wood for the trees and to develop a dislike for the subject. To take one example of this excessive detail and of lack of balance between one topic and another, nearly forty pages are devoted to what the authors term the metabolic "rugged individualism" of the amino-acids, whereas the absorption of fat is dismissed in a couple of pages

More might have been said about how some of the important advances in biochemistry have been made. For example, in dealing with carbohydrate metabolism, some description might surely have been given of Claude Bernard's fundamental experiments leading to the discovery of glycogen and its role in blood-sugar regulation. Things like this make a subject interesting and they are often remembered by the student, and are worth remembering, when a great deal else has long been forgotten Instead, the student is faced as early as p 3 with about fifty divisions and sub-divisions of the carbohydrates, and on the next page he is further discouraged by finding the names and structures of all twelve D-hexoses where three or four would have sufficed. It is surprising that the authors have not adopted the elegant and more realistic method of Haworth for showing the structures of the carbohydrates. The Fischer formulæ when applied, as they are here, to disaccharides and even to polysaccharides may well strike the student as looking like radio wiring diagrams rather than structures of molecules.

At one point, where apparently the authors felt that the book needed a bit of light relief, there is a deplorable reproduction of a dog which is said to be afraid that the essential amino-acid tryptophan has been omitted from its dish of food. The book needs lightening in a much more substantial way than this if it is to appeal to medical students and give them a lasting interest in biochemistry Nowadays, writers of preclinical text-books ought surely to ask themselves all the time what can be left out rather than what can be put in, and whether the information can be presented to the student in a more vivid and more intelligible way by omitting details and unessential facts

It should be emphasized that these criticisms apply mainly to the book as a text-book for medical students, though that, after all, is its declared purpose As a book for science students with more time for biochemistry, it is in many ways excellent The biochemical reactions and metabolic cycles are well set out in the figures, there are numerous cross-references, and important topics such as enzyme action and metabolic antagonism are discussed clearly and illustrated by helpful diagrams There are a good many minor slips and misprints, but these are perhaps excusable in the first edition of a book containing so much detail. Science students and their teachers will find this a useful, original and up-to-date text-book It should find a place beside its well-known companion volume, "Clinical Biochemistry", by Cantarow and Trumper, which incidentally managed to cover its ground without using any chemical formulæ more elaborate than that of carbonic acid.

D C Harrison

A PHILOSOPHICAL TREASURE-HUNT

Treasury of Philosophy

Edited by Dagobert D. Runes. Pp. xxiv+1280. (New York · Philosophical Library, 1955) 15 dollars

THIS volume is another of the huge compilations so much in favour in the United States It contains extracts, prefaced by brief introductions, from the works of nearly four hundred writers, they range from Anaximander to Sartre, from Chuang Chu to Johann Comenius. There are excerpts from the works of Oriental philosophers and theologians, medieval Hebrew writers and the Arab commentators on Aristotle Some of this material is, we are told, here made available in English for the first time, though the translators are frequently not named. It is valuable to have some indication of the views of the less well known of these thinkers. The editor observes with some justice that American philosophers are too much neglected in European surveys of the subject, and accordingly he tries to remedy this deficiency Unfortunately, he has included the work of unimportant people like Henry Ward Beecher and Amos Alcott, the father of Louisa May, who ramble on in the folksy 'philosophizing' vein of Will Rogers It is very surprising that no reference whatever is made to what is probably the most remarkable American contribution to philosophy, the "Treatise on Language" by Alexander Bryan Johnson, published in 1836.

The book as a whole is vitiated by two serious deficiencies There is no principle of selection, in fact, Dr Runes admits that he has no clearer conception of philosophy than that it is "the search for the undefinable", and he asserts that the only thing common to the contributors is that they have at some time "sat down to meditate upon the wondrous themata that came to their minds in uncharted realms". It is scarcely surprising that such a wide-meshed net has failed to keep out writers like Walt Whitman, Charles Lamb and Maurice Maeterlinck. The second shortcoming is a consequence of the huge scale of the anthology, which is so ambitious as to be self-defeating The extracts are perforce so brief that many are scarcely intelligible For this reason, considerations of price apart, the book cannot be recommended as an introduction to the subject, while anyone with some acquaintance with philosophy will probably find reading it a depressing experience, it is like walking around a dissecting-room scattered with the disjointed members of one's friends.

C K Grant

A TEXT-BOOK OF EMBRYOLOGY

Developmental Anatomy

A Textbook and Laboratory Manual of Embryology. By Dr Leslie Brainerd Arey. Sixth edition. Pp. xi+680. (Philadelphia and London W. B. Saunders Company, 1954) 47*s.* 6*d.*

THE present volume has been extensively revised in the light of recent developments in embryology. In addition, the material in the book has also been rearranged so that there are now twenty-eight chapters instead of twenty-three The aim of the author has been to subdivide larger chapters of earlier editions of the book "into shorter and friendlier units". In this aim he has succeeded A consistent policy throughout the book has been to use larger type for "basic information" and smaller type for so-called "supplementary information" It is debatable whether this approach is desirable in a text-book which is essentially for students The average student is in doubt as to whether or not to leave out the supplementary material

The book is divided into three main parts.

Part 1 deals with general development and includes chapters on fundamental concepts, reproductive physiology, placentation and experimental embryology and teratology. Part 2 is essentially devoted to organogeny, and Part 3 is in the form of a laboratory manual.

The experimental approach to the pertinent developmental mechanics is admirably dealt with as a separate entity in a chapter on experimental embryology Details concerning developmental mechanics of different organs are also discussed in a brief summary under the heading of "Causal Relations" in the appropriate chapter. In most instances this discussion is useful and valuable, but in others it is much too brief

Part 3 of the book is in the form of a laboratory manual and deals with the embryology of the chick in the earlier stages of development and also with the anatomy of the 10-mm. pig embryo The embryology of the chick is undoubtedly of value in the details which it gives to the student of biology, for the medical student it is much too detailed One would have preferred to have had the anatomy of the 5- and 10-mm human embryos given, instead of that of the pig This section and, indeed, other chapters in the book should have photographs of sections of embryos rather than semi-schematic drawings.

The revision of the book has been carefully carried out The author must be congratulated in producing a readable book of reasonable dimensions in a subject which is rapidly expanding The publishers must also be congratulated on the excellence of the reproduction and the general format of the book

W. J Hamilton

SCIENTIFIC PROGRAMME OF THE INTERNATIONAL GEOPHYSICAL YEAR 1957–58

By PROF. SYDNEY CHAPMAN, F.R.S.

Introduction

THE International Geophysical Year is the name associated with a forthcoming large-scale scientific study of the earth, now being planned and prepared. It will in our generation be the culmination of a long series of such efforts extending from the distant past. In the third century B.C., the Alexandrian natural philosopher Eratosthenes first measured the size of our globe. In A.D. 1600 William Gilbert's treatise on magnetism and electricity announced that the earth itself is a great magnet. Halley's undergraduate astronomical excursion to St. Helena in 1676 to observe the southern stars helped to lead him ten years later to produce the first extensive meteorological chart, of the trade winds. His magnetic voyages in the north and south Atlantic during 1698–1700 bore fruit in 1700 and 1701 by his publication of the first global magnetic charts. In the eighteenth century the French geodesists re-measured the globe by observations in Peru. Early in the nineteenth century Maury applied his studies of the winds to navigation by sailing vessels, and initiated world co-operation in maritime meteorology. Since the second half of that century, international scientific co-operation, particularly in geophysics and astronomy, has developed apace. The first and second International Polar Years of 1882–83 and 1932–33 were organized mainly for arctic observations of magnetism, meteorology and the aurora (the Second Polar Year only, not both First and Second as stated in *Nature* of January 8, p. 55, fell near sunspot minimum); in 1902–3 there was a concentration of scientific effort, on a smaller scale, in the Antarctic. The International Geophysical Year will be a fit successor to these earlier enterprises, far surpassing them in scope and intensity.

The Arctic, the Antarctic and the tropical belt, together with the meridians 70°–80° W., 10° E., and 140° E., will for the Geophysical Year programme as a whole be regions of specially intensive and complete investigation. The meteorologists will add many other special regions for their part of the programme. The effort to be devoted to the Antarctic will be an outstanding feature of the enterprise; no less than twenty-one antarctic stations are planned, which should lead to a major advance in our knowledge of a part of the earth of which in some ways we know less than we do of the moon.

Meteorology

As in the two Polar Years, meteorology will be one of the main branches of the investigation. The range of observation will be global, not only or mainly arctic. In the first Polar Year the observations were made at the earth's surface; in the second Polar Year the atmosphere was explored in height as well as on the surface: the results were signalled by radio to the ground, thus obviating the need for recovering instrumental records from balloons the landfall of which could not be predicted. A major aim during 1957–58 will be to extend this exploration in height over a much greater part of the globe than hitherto, and to higher levels than before—especially in the tropics, where the troposphere is more than twice as deep (there approaching 20 km.) as it is at the poles (about 8 km.). At the standard meteorological stations the plan is to measure the height distribution of air temperature twice daily, and of wind four times daily, up to 20 km., and wherever possible—especially on the Regular World Days (three per month)—up to 30 km.; on these days, when observations are to be specially intensive and widespread, the temperature observations are to be made four times daily.

The main objective will be to study the general circulation of the atmosphere, and the interchange of heat, momentum, angular momentum and entropy between the different parts of the globe. Hence the winds will be specially observed, by radio echoes from balloon-borne reflectors, and also by cloud observations from land and from ships at sea. The meteorological influence of the large-scale topography of the globe—the continents and oceans, and the great mountain chains and massifs—will be investigated. The familiar surface measurements of precipitation, and of air and surface (soil or water) temperatures, will be made more extensively, especially over the oceans; many small oceanic islands will be centres of scientific work of these and other kinds.

Besides the above fundamental measurements, the programme includes more widespread and extensive study of the atmospheric height distribution of ozone and water vapour; of solar and terrestrial radiation (including the albedo of the earth, as indicated by earth radiation reflected from the dark face of the moon); of the high 'mother of pearl' clouds and the far higher luminous night clouds; of thunderstorm regions over land and sea, by radio records of atmospherics; and of the chemical composition of the air, for example, its oxygen and carbon dioxide content in the Antarctic. Rockets will extend the exploration of the atmosphere far above the heights attainable by meteorological balloons.

Under the guidance of the World Meteorological Organization, and with the co-operation of the International Association of Meteorology, instruments and methods of observation and publication will be standardized, and plans made for the handling and discussion of the immense mass of observations thus to be collected. The oceanographic programme of Geophysical Year observation will be an important supplement to the meteorological programme.

Geomagnetism

The chief geomagnetic problems to be solved are those relating to magnetic storms—long studied, but never with an adequate network of observatories. During 1957–58 the network of regular observatories will be enhanced, and be valuably strengthened by magnetic recorders installed at many ionospheric (and perhaps also cosmic ray) stations, for their own purpose of gaining early awareness of magnetic disturbance. The methods and instruments will be similar, in the main, to those used during 1932–33,

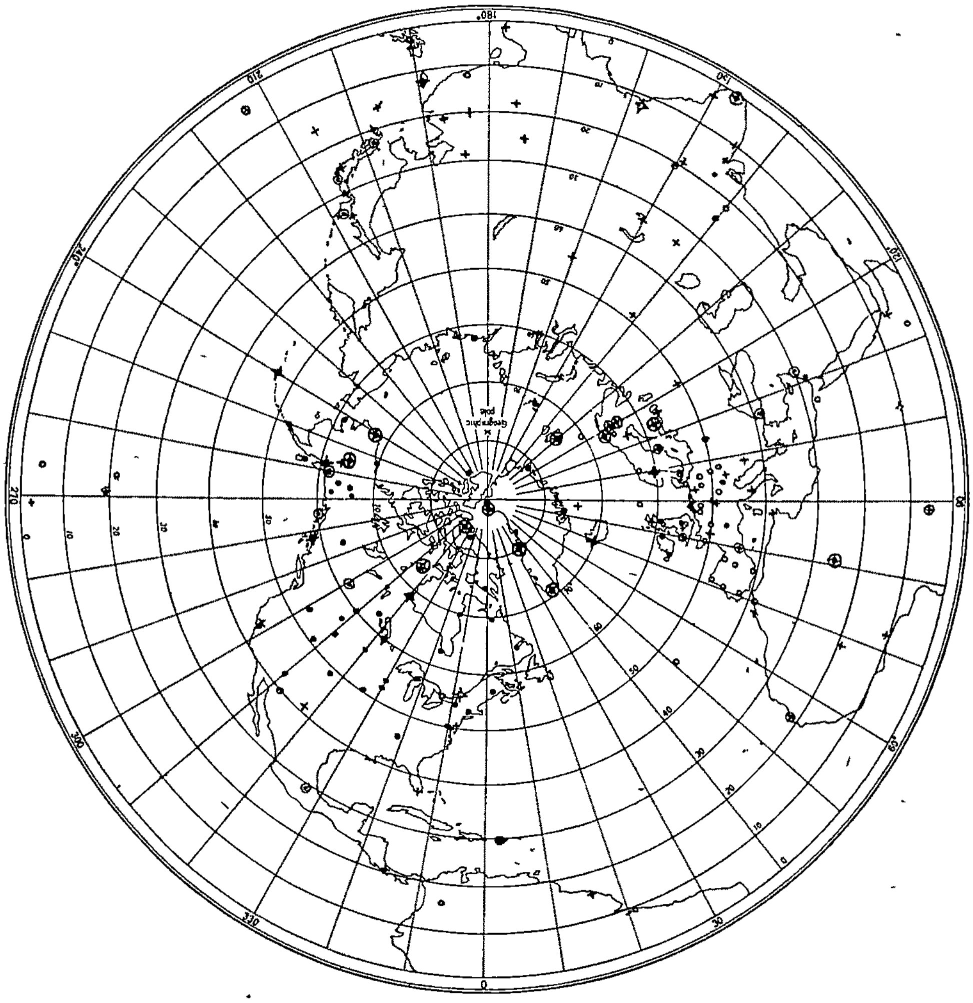


Fig 1 Observation stations in the northern hemisphere for the International Geophysical Year auroral stations ●, ionospheric stations, +, magnetic observatories, O The southern hemisphere will have fewer stations Geomagnetic co-ordinates

but at some stations in or near the auroral zone the space gradients of the magnetic field will be measured, by setting up two satellite sets of recorders some miles distant, one to the north or south, the other to the east or west, these satellite stations, near enough to be managed by the staff at the main station, will, it is hoped, contribute materially to our knowledge of the intense systems of electric currents in the arctic ionosphere These currents will also be explored in more detail, and closer at hand, though only for a few brief intervals of time, by magnetometers carried into or near them by rockets launched in high latitudes during magnetic storms.

Special care will be taken to avoid loss of record (such as occurred all too often in the past) during any very great magnetic storms that may befall during 1957–58

The concentration of daytime electric current over or near the magnetic equator will be more fully observed by an increased number of tropical magnetic observatories.

Improved and more extensive recording of magnetic pulsations, and also of earth currents, will be further important features of this part of the programme. As a contribution to the correlation of geomagnetic with other data, it is expected that indices of geomagnetic activity will be made available for each quarter-hour throughout the Geophysical Year, instead of, as now, for each three-hour interval.

The Aurora

The International Geophysical Year is too brief an interval to afford much improvement in the long-range statistics of auroral frequency, but it should mark a great advance in the observation of the many auroræ that may be expected to occur during the Year. In the regions where auroræ are often visible, at geomagnetic latitudes 60° and more, there will be a network of auroral stations equipped with automatic cameras that will photograph the whole sky every five minutes throughout each night, these will afford a synoptic view of the terrestrial extent and of the changes of auroræ never hitherto realizable. (Incidentally, this may also provide valuable data concerning cloud cover) At some of these stations there will be automatic scanning spectrographs giving a succession of spectra of the auroral light in the vertical meridian plane, over nearly the whole arc from horizon to zenith to horizon. In rather lower geomagnetic latitudes, where auroræ are less often visible, there will be a few stations similarly equipped, and there will be networks of visual observers, including some on sea as well as land, some equipped with angle-measuring devices, and with filters to isolate different spectral bands of the auroral light (thus cutting down the background sky light, especially during twilight and moonlight), some stations may have colorimeters designed to record the nature of the auroral light less elaborately than by spectrograph Air pilots will take part in such visual observation, with special benefit when the sky is overcast. It is hoped that the network of careful visual observation will be extended into low latitudes, where the work should be much aided by the world system of warning of expected magnetic disturbance, professional, volunteer and other aid from meteorological and other organizations will especially be sought in these regions of lower latitude A watch will be kept for the simultaneity of appearance of auroræ at the two ends, northern and southern, of a line or lines of geomagnetic force, or at pairs of stations in nearly the same geomagnetic longitude, and nearly equal northern and southern geomagnetic latitudes The possibility of such observations is determined mainly by the availability of sites for fixed stations in high southern geomagnetic latitudes. For example, Macquarie Island (54 5° S, 159 0° E. geographic, 61 1° S, 243 1° E geomagnetic) could be paired with an Alaskan station to the south-west of College, Alaska, and Heard Island (53 0° S., 73 4° E, 61 2° S, 129 9° E) could be paired with a north Siberian station. Means of intercommunication between such pairs of stations would be useful though not essential.

Some radio observatories will explore the auroral regions by short-wave beams echoed back to the station by suitably placed auroræ, by this means auroræ can be detected and located from a considerable distance, independent of cloud cover, and by day as well as by night Any radio waves emitted from the aurora itself will also be registered

Measurement of the increased scintillation and absorption of the radiation received from radio stars, when it passes through an auroral region, will be another and novel means of study of the enhanced ionospheric turbulence and ionospheric drifts associated with auroræ

Special spectrographic studies will be made of the Doppler effect in the light of the hydrogen atoms which rush downward along the auroral rays and are scattered in all directions near the base of the rays. These or accompanying electrons will be detected and counted by ionization chambers borne by rockets launched from balloons

The Airglow and the Zodiacal Light

All over the globe the upper atmosphere emits light, the airglow, which in general is too faint to be visible to the eye or to be photographed directly with short exposure, though sometimes patchy, it does not have the definite forms generally shown by the aurora. It is enhanced at twilight, and is observable also by day from rockets high above the atmospheric layers where the beam of solar radiation is scattered to give the general sky light Its geographical distribution, changing with time of day and with season, will be investigated during the Geophysical Year, by means of scanning photoelectric photometers sensitive to four or more spectral bands of the radiation These instruments, which automatically survey the entire sky each half-hour, will be disposed at intervals along a meridian chain, beginning at Thule, Greenland, and, crossing the auroral zone, extending through Canada, the United States and Mexico, others will be in Alaska, Hawaii and the Belgian Congo Less complicated photometers, recording or visual, will be placed at further stations, the observations will necessarily measure, besides the intensity of the airglow, that of the auroral light, when present, and (in low latitudes) the zodiacal light All these photometers will be carefully calibrated by astronomical methods or by the use of fluorescent surfaces activated by radioactive material of long life.

In addition, spectrographic and interferometric studies of the airglow will be made at a few special stations, and some high-level spectral observations will be made from rockets Such studies will deal in detail with the various components of the spectrum of the airglow, its green and red atomic oxygen lines, the oxygen (and possibly nitrogen) bands, the yellow doublet of atomic sodium, and the strong infra-red and other radiations of the hydroxyl molecule OH.

Cosmic Rays

As for the airglow, so also for cosmic rays, the Geophysical Year will be the first occasion on which a prolonged simultaneous standardized scheme of world-wide observation will be operated. Two main types of instrument will be used in this survey, one a counter telescope to record rays of relatively high energy, the other a neutron monitor for the low-energy part of the cosmic-ray spectrum. The ionization-chamber counters already in operation at several stations should continue also throughout 1957–58. Detailed indications of the construction and operation of the two standard types of instrument will be made available in good time by the Geophysical Year Sub-Commission of the International Union of Pure and Applied Physics. It is hoped that the synoptic network will include sixty or more stations disposed in the special Geophysical Year areas (zones and meridians) and elsewhere, many of the instruments may be located at meteorological, magnetic or ionospheric stations

As in other branches of the Geophysical Year work, plans will be prepared for standardized forms of recording the synoptic observations, for interchange of observations between stations, and for publication

Additional special cosmic-ray investigations are planned, including moving photographic-emulsion records of the heavy-particle component, and high-altitude observations to determine the momentum spectrum, from mountain stations, aircraft, balloons and rockets But the main emphasis of the cosmic-ray programme will be on the investigation of geomagnetic, aeronomic and solar problems to which cosmic-ray observations may be able to make a distinctive, perhaps unique, contribution

The value of these observations will be greatly enhanced by the unprecedented array of solar and geophysical data available during the Geophysical Year

Solar Observations

The Geophysical Year will be at or near a sunspot maximum which is expected to be of considerable but not exceptional intensity Because so many geophysical phenomena are related to solar activity, it is hoped that this will be continuously observed in the several different ways now possible. To this end, the observing hours at solar observatories will be extended in order to give an overlap of the periods of observation at stations in different longitudes, so that spells of cloudy weather at one or other station may not break the continuity of record. The long-continued records of sunspot numbers, their positions and areas, of prominences and faculæ, will be supplemented by spectroscopic, spectrographic and photographic observations of solar flares, by spectrophotometric observations of the inner corona, and by records of solar radio emissions and their polarization, at a series of wave-lengths. Interferometric studies of the location of the radio sources will be made. Further, rocket spectra of sunlight at successive high altitudes will be photographed at intervals throughout the Geophysical Year.

Some solar observatories will equip themselves with recorders of atmospherics, which can give visual indication or audible warning of the beginning of solar flares, because of the improved propagation at such times. This will enable special observations to be made outside the normal 'solar patrol' periods.

The distribution of the line-of-sight component of the magnetic field of the sun will be mapped over the solar disk two or three times a day, by the Babcock method, at Mount Wilson and perhaps also at other solar observatories.

The solar observations during the Geophysical Year will be of cardinal importance to the scheme of world notification of Alerts and Special World Intervals, at times when magnetic, auroral, ionospheric and perhaps also cosmic-ray disturbances may be expected. Solar data as complete as possible will be vital for the detailed study of the sun's influence on magnetic, auroral, ionospheric, cosmic ray, and perhaps other data to be obtained during the Geophysical Year.

Ionospheric Investigations

The pioneer arctic ionospheric investigations made during the second Polar Year were the most important extension of the programme of that enterprise, as compared with the programme of the first Polar Year. The fledgling of that epoch is now grown to be a major member of the Geophysical Year programme. More than a hundred stations for the exploration of the ionospheric layers overhead, by vertical beams of pulsed radiation, are expected to be in operation during the Geophysical Year; their distribution will in large part conform to the general plan of concentration along particular zones and meridians; but the considerable influence exerted on the ionosphere by the geomagnetic field will be taken into account by siting some stations with special reference to geomagnetic latitude, that is, to latitude relative to the axis of the main (dipole) component of the earth's field, with its north geomagnetic pole at 78·6° N., 70·1° W. (1945).

This now standard method of ionospheric investigation, from fixed stations and also from aircraft, will enhance our knowledge of the complex and changing structure and disturbances of the ionosphere, from the equatorial to the auroral regions. In addition, many special studies will be made, at fewer stations: of tropospheric propagation, of absorption, of ionospheric drift, of both back and forward scatter, of radio star scintillation, of atmospherics, of auroral and solar radio noise, of radio echoes from meteors and auroræ. There will also be direct exploration of the ionosphere, *in situ*, by rockets. The fulfilment of these plans should gather a rich harvest of aeronomic observations for study in association with solar, magnetic, auroral and airglow data. The ionospheric prediction stations in association with the solar observatories will play a vital part in the plan for World Alerts and Special World Intervals.

Longitudes and Latitudes

In the past there have been two world-wide determinations of the longitude differences between major astronomical observatories; the later one was in 1933. During the Geophysical Year, both the longitudes and latitudes, and the variations of these quantities, will be determined. This will lead to improved measurement of time, more precise determination of the irregularities of the earth's rotation, and corrections to star catalogues. The participating observatories will be those associated with the Bureau International de l'Heure, and, it is hoped, others newly organized and equipped, in areas where there are great gaps, especially near the equator and in the southern hemisphere. New types of fundamental instruments will be used.

In addition, a new method will be applied to determine the mutual relation of the geodetic networks covering the continents, by frequent photography of the moon against the background of stars, from about twenty well-distributed observatories; by this technique it is expected that the uncertainty of the extent of the oceanic gaps separating the networks will be reduced from 200–300 ft. to about 100 ft.

The availability of the great store of meteorological and ionospheric data to be obtained during 1957–58 will materially assist these undertakings.

Glaciology

The extent, character and behaviour of glaciers and snow cover will be measured in many parts of the world; this simultaneous survey will be far more geographically comprehensive than any made hitherto, and will be of great importance to meteorology and climatology. Apart from direct measurements at or from fixed stations, air reconnaissance will be used. Fixed survey points will be set up on selected glaciers in order that changes may be adequately determined by future comparison with later observations.

One great objective is to investigate the ice morphology and measure the total ice content of Antarctica. In this plan the co-operation of American, Australian, French and perhaps other nations is hoped for. It is anticipated that, with the aid of special aircraft, widespread seismic surveys will be made to determine the thickness of ice over the whole continent, and to settle the geography of the coast under the ice cover. This survey has special importance for the long-term climatological prediction of sea-level changes. The limits of permanent ice—a matter of present interest and valuable for comparison with future surveys—should be charted with considerable accuracy.

Oceanography

Many great problems of the oceans, especially in the southern hemisphere, await solution. Several ocean survey vessels belonging to the United States, Britain, West Germany and other nations will work on a co-ordinated plan during 1957–58. The water circulation, sediments and crustal structure will be studied along two meridians, and the measurements will include water velocities determined electromagnetically, and the heat exchange between sea and air, as well as the customary temperature, salinity and other standard measurements. About forty new stations will be set up, equipped with tide gauges and non-tidal long-wave recorders, on many islands and on some continental coasts The shifting boundary between temperate and arctic waters, and the warming of the Arctic, will be studied. Continuous echo sounding, registration of magnetic intensity by towed instruments, collection of plankton by towed nets, radiocarbon sampling of the deeper waters, measurement of temperature gradients in sediments, collection of long sediment cores, and seismic reflexion observations will be among the activities of some of the oceanographical ships, these will also be available, so far as possible, as moving 'stations' for other types of geophysical observation.

Seismic and Gravity Measurements

The Geophysical Year will provide opportunity for seismic recording and gravity measurements to be made at many antarctic and island sites not ordinarily accessible or available, and it is expected that many expeditions will include such work in their programme.

The Rocket Programme

Rockets provide the most important new technical feature that distinguishes the Geophysical Year from the second Polar Year. They will enable the atmosphere to be explored over a much increased range of height in various ways, and may considerably extend our understanding of upper atmospheric processes and our knowledge of solar phenomena that affect the earth The technical advances that are involved concern not only the rockets themselves, but also the measuring devices they carry The measurement of atmospheric properties by instruments travelling at high speed presents difficult problems During the past decade American scientists have made remarkable progress towards their solution, and the tide of invention in this field continues to flow strongly.

In most of the upper-atmospheric rocket researches thus far made, large and very expensive rockets have been used, launched from a desert site in New Mexico, with costly ground installations. The smaller rockets of this type can be, and have been, launched also from specially fitted ships Recently, however, a much cheaper method of rocket exploration has been developed by Van Allen and his colleagues. The rocket is carried up to a considerable height by a large balloon, and launched at a predetermined pressure-level. The launching heights have ranged up to 27 km, and the heights attained have at times exceeded 100 km The load that can be carried up to about 100 km is 15 kgm, which permits a wide variety of researches, such as those on cosmic rays, ozone, pressure, density and temperature, the solar spectrum, the sky brightness and airglow, geomagnetism, auroral particles, and ionospheric physics The combined rocket–balloon system is called a 'rockoon'. Investigations are in progress into the vertical launching of rockets from aircraft, and if successful may contribute to the Geophysical Year programme

The American National Committee for the Geophysical Year plans to fire approximately thirty-six large rockets ('Aerobees') and about a hundred rockoons, distributed throughout the period, and also geographically, from the Arctic to the Antarctic. Many of the above researches, if not all, will be included in the programme The French National Committee plans to launch twelve of the large French rockets ('Véronique') from the Sahara, in pairs, at intervals, their instruments are expected to measure pressure and density, ionization, solar radiations, and particle masses (by mass-spectrograph). It is greatly hoped that other nations will also contribute to the rocket programme.

Problems of Organization and Finance

The achievement of the Geophysical Year will depend on the effort and funds devoted to it by the different participating nations Naturally, their contributions will be unequal in magnitude and kind, help will be afforded by some nations to other nation-partners in the enterprise, by provision of instruments, training of observers, reduction of observations and in other ways. The unprecedented volume of observations that will accrue will present problems of collection and discussion for which detailed plans are not yet made. Many important points as to methods and recording of observations, and standardization and calibration of instruments, await settlement Some important nations have still not associated themselves with the Geophysical Year. Thus there remains much scope for effort and thought in order to render the enterprise as successful as possible. But the stage already reached, more than two years before the Year begins, is good ground for confidence that the scheme will far surpass every previous co-operative scientific effort of its kind, and that it will lead to notable advances in knowledge of importance and interest to mankind. When the Geophysical Year ends, the level of activity in geophysical observation will necessarily drop rapidly and considerably, but past experience indicates that the subsequent level will still mark a distinct rise above the present level; thus it will afford a higher stage from which at some later epoch another International Geophysical Year can mount to yet greater heights and intensity.

A PATTERN FOR INDUSTRIAL RESEARCH

In 1953, seven senior executives of the United Steel Companies, Ltd., were invited to lecture to engineering undergraduates in the University of Cambridge on various aspects of industrial management. The lectures have now been presented in book form*, and among them is a valuable contribution to contemporary thinking about the organization and application of scientific research in industry by Dr. J. H. Chesters, assistant director of research to the Company

The research worker in industry spends a good deal of time on development work that adds little to scientific knowledge, on the other hand, his best achievements are often based on fundamental data which he himself has collected or been able to appreciate and apply.

---

* Industrial Management a Course of Lectures given at Cambridge University for the Faculty Board of Engineering Pp 124 (Sheffield United Steel Companies, Ltd, 1954)

The usefulness of a research department depends primarily on the originality, initiative and effort of the staff, but the framework within which research workers function greatly influences the results

The research department may vary from one man to giant organizations, such as Bell Telephones, which must be considered as plants in themselves and indeed, in the United States, are registered as separate companies. In Great Britain there is wide variation (0 4–5 3 per cent) in the research and development costs expressed as a percentage of turnover in different industrial groups In the scientific instrument and light electrical engineering industries the figure is more than 5 per cent, in chemicals 2 4 per cent, whereas for the ferrous industry and for food, drink and tobacco it is only 0 4 per cent In general, the older the industry the less is its present investment in research. One reason for this is that iron and glass can be made, and indeed have been made, without any precise scientific knowledge, but radio sets would not even have been thought of unless a great deal of fundamental research had been done

A research unit consisting of a university graduate backed up by two assistants can be run for an average expenditure of £3,000 per annum In the United States, industrial research activities account for less than a half per cent of the cost of goods and services of the undertaking

Research in the United Steel Companies costs approximately a half per cent of all sales. There is a total staff of almost two hundred, who study all the major aspects of iron- and steel-making in metallurgy, engineering, physics, chemistry, mathematics and geology.

The possession of a first- or second-class honours degree is by no means the sole criterion in the choice of an industrial research worker. The ability to work in a team has long been recognized as equally vital, the isolated research worker being now something of a curiosity. The old vertical-type team consisted of a section head with his senior and junior assistants The new type team—which is of a horizontal character and requires the fullest co-operation between different section leaders and their staffs—calls for an even higher conception of team-work

The efficient use of specialists demands that they be supported by other workers who do not require to be as highly qualified. In the United Steel Companies about a hundred university graduates and men with equivalent qualifications are backed up by more than a hundred other members of staff, many of whom left school when they were sixteen, but have since acquired considerable skill in some particular field of activity. The old idea of 'lab. boys', who often finished in blind-alley jobs, is rapidly dying out

The senior staff, too, are encouraged to continue their studies and to join appropriate scientific or technical societies By so doing they not only increase their background of knowledge, but also get the opportunity of 'sparking' their minds on those of workers in other fields

Considerable experience now exists on the building of research departments, and such elementary mistakes as putting dirty and clean work adjacent to one another, or heavy machinery near equipment requiring freedom from vibration, rarely occur Where a new laboratory replaces an old one certain new problems arise, notably the clash between the desire to have a smart modern laboratory and to do work that can be far more efficiently carried out if a certain amount of mess is permissible The best, though still imperfect, answer would seem to be the segregation of 'dirty' activities in either a separate block or outbuilding

Another risk with new and impressive laboratories is that the worker is less inclined to use the 'string and sealing wax' technique Unless encouragement is given to start with rough equipment there is a tendency for the research man not to start his experiments at all until he has designed what he considers to be a good-looking piece of equipment. Far quicker results would be obtained and much money saved if at least early work is done with a crude assembly, and this only converted to an engineering job where accuracy or long-term use demands

The jobs tackled in an industrial research department can be conveniently divided into those which arise internally and those arising from external demand The latter may come direct from the plants or arise from long-term policy laid down by high-level management or the numerous technical committees that form so valuable a part of large-scale industry.

External demand is not, of course, limited to the works, it includes the demand by customers for materials to meet more arduous service conditions or for the solution to a problem that is difficult to solve by engineering means. An example of the latter was the joining of austenitic and ferritic tubes, the different coefficients of expansion of which would affect the tightness of a bolted joint, or the stresses in a plain butt weld in conditions of fluctuating temperature An appreciation of the desirable characteristics of such a joint in service and the potentialities of an extrusion press in producing the necessary conditions for making a pressure weld enabled a tubular transition piece to be evolved which consisted of a ferritic tube gradually tapering to zero thickness inside an austenitic tube increasing at the same rate from zero to the full tube thickness

At least a third of the solution to a problem lies in stating it correctly, research work often suffers because the true nature of the problem is not appreciated before the work began. A close examination at the start may even show that the problem does not really exist, is trivial, or such that a solution would yield little benefit. In the United Steel Companies all major items of work in the research department are covered by means of investigation sheets, which state in a few paragraphs the nature of the problem, the method by which it is to be tackled, and a list of the plants expected to benefit if a useful conclusion is reached

Most research departments carry more investigations than they are really capable of handling. This leads to double dissatisfaction, the user being depressed because his problem gets little attention, and the research worker annoyed because he is perpetually asked to report on investigations on which he has done no work for some time A rough rule is that the number of investigations in a section should not exceed that of the staff.

It is a tradition with research workers that they commence an investigation by searching the literature. The industrial worker rarely has time to do so at all fully, but can be greatly aided by an information section which keeps him continually informed of developments in his field, and can cover a far wider range of literature than he can ever hope to do by his own specialized reading

Speed is frequently vital in industrial research. There are occasions when, to be of value, information must be provided within a day. If the research organization is sufficiently flexible, such demands can sometimes be met. The research department was once asked at 9 a.m. whether the collapse of a new steel furnace roof was due to poor brick quality or to operating procedure. The roof had to be replaced that night, and any answer after 5 p.m. could not affect policy for the next furnace campaign. By switching all the staff of the refractories section to the problem, all the standard properties of the suspect-bricks were determined and a report issued over the telephone at 5 o'clock to the effect that there was nothing wrong with them and that the same quality should therefore be employed in the new furnace. The subsequent behaviour of the furnace showed this to be the right decision.

The object of research should be the provision of genuinely new information in which is included quantitative research hitherto only understood qualitatively. The results obtained may at first prove unpalatable, because they conflict with previous assumptions.

From the practical point of view, a result opposite to that anticipated frequently proves to be of value. As an example may be cited war-time troubles with induction furnace linings, due to the loss of the previously used Austrian and Greek magnesite. At the time and on an apparently sound theoretical basis, it was believed that the ultimate test for induction furnace lining materials was their ability to withstand high temperatures without shrinkage—shrinkage cracks being thought to lead to metal penetration and a consequent strike to the high-voltage water-cooled coil. This hypothesis was overthrown by the results of laboratory tests on a wide range of linings, which showed that the satisfactory ones frequently had a high shrinkage when heated to 1,600° C., while those that failed mostly showed a low shrinkage.

A large proportion of the more important developments arise from accidental observations. This was seen in the metallurgical field by work on boron, which was added among other materials to 0.5 per cent molybdenum steel to prevent the cracking of steam pipes. It was noted that the boron–molybdenum steel had twice the proof stress of mild steel and yet possessed similar weldability. Realizing that such a steel would be of great value in reducing the weight of engines and structures, its properties were thoroughly investigated and this led to a valuable contribution in aircraft gas turbine design, and the provision of light-weight structures generally.

Assessment of a job frequently indicates that an efficient attack requires the cutting across of section boundaries. Development of a new-type furnace, for example, may demand co-operation with those concerned with such primary aspects as flow pattern and combustion on one hand, and design and development engineers on the other, the latter putting an engineering interpretation on what may have started as a rough sketch.

It is often assumed that such co-operation should be easy with scientific workers, since they are solely concerned with the discovery of truth. In actual fact, they are just as liable to be upset if credit goes elsewhere for work they have done. The techniques for ensuring that credit in team-work is given where it is due are still very much in the evolutionary stage. One method is the symposium, in which the various contributors are given a place that is at least roughly related both qualitatively and quantitatively to their own contribution to the work.

Industrial research departments can be classed into those which like to keep everything secret and those which are willing to talk of almost all the work they have in hand. It is the latter approach which will ultimately survive, since the willingness to give generously of information without guarantee of return seems essential to healthy development.

Good reports of research are essential, since they are the foundation of future work; the research worker must be prepared to finish his report with clear and concise conclusions and recommendations. Most young research workers, and some older ones, object to writing a report until the work has reached a stage where they feel they can give a full answer to the problem. The result is that the practical man is starved of information for long periods, while the research worker frequently gets so involved in his deliberations that he ceases to see the problem at all clearly. The right answer to this difficulty would appear to be the issue of interim reports. Sometimes, it is desirable to follow the series with a summary report in which the chaff can conveniently be separated from the wheat. Moreover, if the research worker is incapable of putting his discoveries into simple language, it may well be because he does not really understand what he has found out.

On costs the research director should be given a reasonably free hand. "How do you *know* that research really pays ?" is by no means an easy question to answer, particularly where research is mainly concerned with the improvement of a product. Where it deals equally with production processes, however, it is frequently possible to show that the savings associated with quite a small number of investigations are of such a high order as to leave no doubt whatever regarding the overall economics of the research department.

The research director's attitude to patents will be greatly influenced by the type of work done in his department, and also the general policy of the company. Some firms publish little, but take out many patents, others have few patents but publish almost everything. It is often doubtful whether the benefits gained are not more than offset by the trouble and expense involved.

There is still much to be learned about the technique of applying scientific ideas in industry. The major problems are more often psychological than technical, and the ability to tackle them depends more on the personality of the individuals concerned than on their academic achievements. Wherever possible, those likely to use the results should be in touch with the research work as it proceeds, starting sometimes to apply to new ideas before any report is issued.

It is frequently found that the economics of a procedure suggested by research can only be assessed on the plant itself. This means that large-scale trials must be organized and data collected which will enable costing to be done. Where the industry is of a type that owes its origin to scientific research, like chemicals or electronics, such trials present few psychological difficulties.

In the older industries the position is very different, there being a conscious or unconscious struggle between the craft of the 'witch-doctors' and the new ideas of the 'backroom boys'. Between these extremes lies a wide field for diplomacy, the need of the scientific worker for more precise information on plant performance being balanced against the extra worries which such trials place on works staff

Sometimes the application of a new idea or device is delayed because of a natural desire on the part of production executives to see whether it operates successfully elsewhere before committing themselves to major expenditure In such cases, trials on small units can often speed application to larger units A good example of this was the application of a metallic recuperator to reheating furnaces. A new design, developed abroad, was felt to be promising, but lack of previous experience caused hesitancy in applying it on new soaking pit furnaces. The construction and exhaustive testing of a small recuperator attached to a works' furnace gave results which were sufficiently promising to lead to large-scale applications both in the United Steel Companies and in other industries.

OBITUARIES

Miss M S Johnston

Miss Mary Sophia Johnston, second daughter of the Rev. W. A. Johnston, rector of Acrise, Kent, was born at Folkestone on October 29, 1875, but spent the greater part of her life first at Wimbledon and then at Kew, Surrey. She became keenly interested in geology as a girl and very soon established her position among the amateurs in days when women geologists were few. Her interests lay mostly in stratigraphical and physical geology, and it was on an aspect of these that she wrote her best-known paper (with the late Miss M C Crosfield) on "The Ballstone and Associated Beds in the Wenlock Limestone of Shropshire".

Until age somewhat curbed her strenuous activities, Miss Johnston was a constant and energetic participant in the field meetings of the Geologists' Association (which she joined in 1898), while she had field experience of foreign geology at several meetings of the International Geological Congress, at the Toronto meeting of the British Association, and by travel in Egypt On all these occasions she collected assiduously Thus she built up a remarkable collection, which was always at the use of students and which she presented ultimately to the nation and to various universities She wrote on some of her observations abroad, and also lectured extensively about them

Miss Johnston had a life-long interest in archæology and heraldry, and compiled historical pamphlets on Richmond (Surrey) and Kew.

She was proud of being one of the first, small group of distinguished women elected as Fellows of the Geological Society of London in 1919. She served as an officer of the Geologists' Association for twenty-one years (and was made an honorary member in 1939), on the Council of the Palæontographical Society, and as treasurer of the South-Eastern Union of Scientific Societies She was a fearless but very fair critic on committees, where she displayed a fine sense of financial rectitude

Her scientific friends knew Miss Johnston as an ever-helpful and charming personality It was left to those more intimate with her to know of her generosity to Kew churches and of her valuable work for youth No account of her would be complete without reference to the active benefactor she was to one of the Richmond boys' schools and to various tradesmen's rowing organizations. She was also an officer of several of the latter and guided them wisely for many years (in one case she was honorary treasurer for more than twenty-seven years until her death).

Miss Johnston maintained her activities and interests to the last, and her death, after a short illness, on January 23 was a shock to her many friends H. Dighton Thomas

Mr Eric Parker

From his schooldays at Eton until his death on February 13, Eric Parker was able to enjoy his love of the countryside. When he could no longer get about on foot, he drove himself around his beautiful garden at Feathercombe, near Godalming, in his electrically propelled chair. His last book, "Surrey Gardens". was published a year ago, and to gather material for it he visited eighty-four gardens

Though he wrote so much on shooting and fishing, the pleasure he got from sport took second place to his interests as a naturalist. His eye was attracted by the detail of all around him the water rat biting off the head of a lily, martins flying south as high as he had ever seen them, on a warm westerly wind in October, the change in the song of a bird, the wild-flowers of the hedgerow

Before he joined the staff of *The Field* in 1910 to take over the shooting from James Harting, he was writing prolifically, at one time for *The Field*, *The Spectator*, *The County Gentleman*, *The Gamekeeper*, which he edited, and *The Cornhill Magazine* At the time when he was editor of *The County Gentleman*, he formed a great friendship with Anthony Collett, for whom he did the illustrations to "British Inland Birds"

Parker never accepted any statement lightly, and this led him to analyse the observations of the early writers on natural history and to compare them with those of recent naturalists and his own He experimented with a bow and arrow to reproduce the drumming of the tail feathers of a snipe. He held the belief that the drumming of woodpeckers is vocal, and in his "World of Birds" he gives accounts of trials he made to prove it and presents the case for and against his own conviction He neither feared controversy nor failed to attack practices he condemned, as in his "Ethics of Egg Collecting" He hated any form of cruelty. He was opposed to tail docking of horses and dogs, and it was mainly due to his attack on the caged-bird sellers of Club Row that the traffic in wild birds was stopped But he had no room for false sentimentality, and in 1931, after he had become editor of *The Field*, he organized a committee to consider measures to be taken against the spread of the grey squirrel

To the Lonsdale Library, which he edited, Parker contributed much, including the volume on "Game Birds, Beasts and Fishes". The many books he wrote at his table before the window through which birds flew in to the food tray were in the purest and simplest English. Anyone reading the 'week-end' books alone could add much to his general knowledge.

On the day of Eric Parker's funeral an incident occurred which it would have given him pleasure to watch. Two of his grandsons saw a field mouse by the roadside which the youngest one gently handled and released R N. Rose

NEWS and VIEWS

The European Organization for Nuclear Research Director-General

Prof. F Bloch is resigning from his appointment as director-general of the European Organization for Nuclear Research as from August 31, and will be succeeded by Prof C J Bakker, professor of physics in the University of Amsterdam Prof Bakker was born in 1904 and studied physics under Zeeman in Amsterdam In 1931 he took his doctorate (cum laude) for research on the Zeeman effect in the spectra of the noble gases. After this he spent a year in London at the Imperial College of Science and Technology, continuing his work in the field of spectroscopy In the following year he became a member of the scientific staff of Philips of Eindhoven, where he did research on certain physical problems in relation to radio However, his interests turned to nuclear physics, and during the War, in collaboration with Prof. Heyn, he started designing a cyclotron for Philips In 1946 he succeeded Gorter as professor of physics and director of the Zeeman Laboratory of the University of Amsterdam He also became director of the Institute of Nuclear Physics, the focal point of Dutch nuclear research

Progress Medal of the Royal Photographic Society: Dr. Julian H Webb

Dr. Julian H Webb, of the Research Laboratories, Eastman Kodak Company, Rochester, N.Y, has been awarded the Silver Progress Medal for 1954 of the Royal Photographic Society for an outstandingly important series of studies of the photographic process extending over many years By a combination of theoretical argument and experiment, he has established some of the fundamental facts which must be accounted for by any theory of formation of the latent image, and followed this by important contributions to the main body of the theory of sensitivity which is accepted to-day, including one of the first discussions on modern lines using the wave-mechanical theory of crystals He has also made investigations of great value into the connexions between the sensitivity properties of single grains and the *H.* and *D.* curve of photographic materials

Felice Fontana (1720–1805)

Felice Fontana, who died at Florence one hundred and fifty years ago on March 9, 1805, was a versatile scientist who made many original contributions to anatomy, histology, botany and toxicology. He was born on April 15, 1720, at Pomarole, near Rovereto, in the Austrian Tyrol, and studied at Verona, Padua and Bologna While he was professor of philosophy in the University of Pisa, he made a favourable impression on the Grand Duke of Tuscany, later Holy Roman Emperor Leopold II, who offered him the directorship of the Natural History Museum at Florence This Museum housed the finest anatomical collection known at that time, including the world-famous coloured wax preparations modelled after Mascagni's dissections. Fontana's observant and creative mind expressed itself in many scientific pursuits As a botanist he made a careful study of the rust of grain and of spurious ergot. As an ophthalmologist he described what is to-day universally known as Fontana's canal or space As a histologist he was one of the first to recognize the cell nucleus, the tubules of the kidney, and the nerve sheaths. As a toxicologist he investigated the actions of opium, of prussic acid and of snake poisons His book, "Ricerche fisiche sopra il veleno della vipera" (1767), is a landmark in the study of serpent venoms. As a chemist, he found that carbon absorbs gases (this was afterwards confirmed by Priestley), and as a clinician he invented an apparatus for administering oxygen in phthisis Fontana died at the advanced age of eighty-five and was buried in Santa Croce, Florence's Pantheon

'Heavy Water' Project in New Zealand

A company known as Geothermal Development, Ltd., in which the New Zealand Government and the United Kingdom Atomic Energy Authority are the sole shareholders, has now been incorporated This is a joint enterprise to undertake the construction of a factory and the subsequent production of heavy water and electric power from geothermal steam in the Wairakei district of North Island, New Zealand. The project has been under prolonged study by scientists and engineers in New Zealand and in the Atomic Energy Research Establishment at Harwell, in collaboration with Messrs. Merz and McLellan (consultants to the New Zealand Government on electric power) and Head Wrightson Processes, Ltd. (consultants to the Atomic Energy Research Establishment on heavy water), and last year a British mission including a number of scientists from Harwell went to New Zealand to discuss details. Geothermal Development, Ltd, is to have a nominal and paid-up capital of £30,000, one-third of which is to be provided by the Atomic Energy Authority and the rest by the New Zealand Government. The remainder of the capital requirements of the Company will be provided by loans, those for the heavy-water plant (estimated at £2,000,000) are to come from the Authority and those for the electric power equipment (estimated at £4,000,000) from the New Zealand Government The board of directors comprises three representatives of the New Zealand Government and two from the United Kingdom Atomic Energy Authority, and Dr E Marsden, a former head of the New Zealand Department of Scientific and Industrial Research, will be associated with the Board It is envisaged that production of heavy water will begin late in 1957 and of electric power a few months later. Initial plant will produce electric power at a rate of about 40,000 kW, and a useful tonnage of heavy water for nuclear power reactors. The Authority undertakes to purchase from the company the whole of the output of heavy water, and the New Zealand State Hydro-Electric Department the whole of net electric power available. Boring and development work at Wairakei have already begun.

Observations on the Palolo Worm of the Pacific

The palolo worm of Polynesia and Melanesia has always been of intriguing interest to naturalists because of its so-called 'lunar periodicity', which is due to a rhythmic productivity of such consistency that spawning occurs each year in the month of November, always on a day or so following the full moon Mr C. Sorenson has observed the phenomena many times at Tokau Reef, Ovalau Island, Fiji. He describes in the *Australian Museum Magazine* (11, No 6, June 1954) the brown-coloured scum suggesting an exudation from the hidden worms in the coral rock which appears in patches three to four days before the actual spawning. When this washes ashore and concentrates along the water line, it emits a sickly decaying odour, which can be detected a hundred or more yards away. While the scum is present, the native population avoids eating red-coloured reef fish and trevally, as well as certain surface fish, including the local barracuda Often before the main spawning there is a minor event, when broken lengths of the hind parts become swollen with the reproductive elements and break off from the main body of the worms At Ovalau Island there are regularly two risings of the worms each year, and at the second, or major, one the shallows over the reef contain masses of worms two to three feet deep in dense patches which are acres in extent The phenomenon occurs between 3 and 4 a m , when the massed worm-lengths rise out of the coral rock in thick rope-like columns , at this stage individuals may be up to two feet long, but soon after reaching the surface they break up into shorter lengths, and final complete disintegration, death and putrefaction follow soon after the coming of daylight and the rising of the sun The local inhabitants await the event with great eagerness and collect the worms literally in tons with every kind of utensil that is suitable The catch is considered a great delicacy and is usually boiled, though some is eaten raw While it is usual for only two risings of palolo worms to occur at the end of each year, as is the case for the Tokau Reef area at Ovalau Island, there appear to be rare departures from this rhythm. One such is reported by Mr Sorenson for Wakaya Island, about ten miles away from Ovalau Island, where four risings occurred in quick succession in 1953 and 1954, the last occurring in January after the third quarter of the moon.

Forests and Climates in New Zealand

As a result of an extensive survey of the forests and climates in the South Island of New Zealand by J T Holloway (*Trans. Roy Soc. New Zealand,* **82**, 2, 329–410 , 1954), some interesting and important conclusions have been reached An analysis of the indigenous forests has revealed many striking peculiarities of forest species and forest type distribution and behaviour in the Western Southland. These peculiarities are shown to be explicable in terms of a hypothesis which states, briefly, that the forests as a whole are in an unstable condition consequent on comparatively recent changes in regional climates , and that, as a result, an active redistribution of species is in progress with the resultant development of a wide range of new, though unstable, forest types This hypothesis appears to have a general application in the South Island. It is shown that the phenomena discussed in this contribution are by no means peculiar to New Zealand forests, but that valid reasons can be advanced for the prominence of certain features in New Zealand forests in comparison with those of other countries The report is illustrated by some good aerial photographs.

Further Education

The role of a regional council for further education in the British system of education is explained in the introduction to the seventh annual report of the Southern Regional Council for Further Education (pp 30 , Reading, October 1954) Apart from the necessary background work to provide information, the Council serves as a forum for deliberation and agreement by representatives of constituent authorities, universities, technical colleges, government departments, representatives from industry and other interested persons The Council advises constituent education authorities. It secures general advice from among its own members, and special advice from the Academic Board and Advisory Committees Among various items referred to in the report is a paper on full-time release for the technical training of operatives in the heating and ventilating trade, and the continuation of teacher-training courses for part-time and full-time teachers at technical institutions

"A New Development in Aids for Sub-normal Vision"

Referring to the communication under this title by J Lederer in *Nature* of November 20, 1954, p 977, A. G. Bennett, 25 Brook Avenue, Wembley, Middlesex, has pointed out that there are two errors in the algebraic calculations H H. Emsley, 36 Meadow Way, Letchworth, has suggested that Mr. Lederer's third-order or Seidel equations are not sufficiently accurate, and that relaxation of accommodation and the assumption of the rotating eye are not justified. Mr. Lederer agrees that there were two algebraic errors in his calculations, revised equations and a new graph show, he claims, that there is no important change in the significant region As regards the use of third-order equations, Mr. Lederer states that their accuracy is sufficient, as evidenced by the field properties of lenses made according to them He adds that clinical study and experience of more than seven hundred cases of sub-normal vision have convinced him that there is no significant accommodative activity in the great majority of such patients, and that they engage in eye movements as well as head movements and movement of the printed matter Many have obtained much better results with such single-lens microscopic lenses giving a large, well-corrected field of view than with compound magnifiers of equal or even higher magnification with a small corrected field

Nairobi Scientific and Philosophical Society : Officers for 1955

The eighth annual general meeting of the Nairobi Scientific and Philosophical Society was held in the Town Hall, Nairobi, on January 28, 1955, at which the following officers were elected for the forthcoming year *President,* Mr D A. Davies , *Vice-Presidents,* Dr H. C Pereira, Mr. H. W. Gill and Dr H. H Storey , *Joint Honorary Secretaries,* Mr J. P Henderson and Mr J Glover (P O Box 931, Nairobi) , *Honorary Treasurer,* Mr. R W Walmsley , *Honorary Librarian,* Dr. D. W Duthie , *Committee Members,* Mr R W Rayner, Mr. H B Stent, Mr C J. Martin, Mr H E Watson and Dr. C C Webster

Conference on Cloud-Chamber Techniques

A conference on "Recent Developments in Cloud-Chamber and Associated Techniques" will be held in the Department of Physics, University College, London, during March 24–26 There will be sessions devoted to the diffusion cloud chamber, the multi-plate cloud chamber, the high-pressure cloud chamber, the bubble chamber, the interpretation of cloud chamber photographs, counter control systems for cloud chambers, and to overcompression and fast recompression techniques The conference will be held under the joint auspices of the Physical Society and University College, London, and members of the Physical Society are invited to attend Further information can be obtained from the Secretary, Department of Physics, University College, Gower Street, London, W.C.1.

Society for General Microbiology: Annual Meeting

The twentieth general meeting of the Society will be held in the Royal Institution, Albemarle Street, London, W.1, during April 18–20. The sessions on April 18 will be occupied by the presentation of original papers, and in the evening the second Marjory Stephenson Memorial Lecture will be given by Prof C. B. Van Niel, of the Hopkins Marine Biological Station, Pacific Grove, California, on "Natural Selection in the Microbial World" On April 19 and 20 there will be a symposium on "Mechanisms of Microbial Pathogenicity". The principal contributions have been collected and will be published as a book which will be made available before the meeting (members of the Society, 15*s.*, others, 25*s*). At the meeting the published papers will be taken as read and the two days devoted mainly to discussions following short summaries or commentaries on the published material by the authors concerned. Applications for the book must reach the General Office of the Society, c/o Institute of Biology, Tavistock House, Tavistock Square South, London, W.C 1, by March 15.

University of Sheffield

The Department of Fuel Technology of the University of Sheffield, which has been traditionally connected with the properties and combustion of coal and coke, has for some time extended the training of its undergraduates to equip them for careers in chemical engineering as well as fuel. It has become increasingly difficult to separate fuel technology from chemical engineering, and there is a very great demand from all types of industry for chemical engineers In recognition of this trend, the Department has changed its name to the Department of Fuel Technology and Chemical Engineering and will train students for careers in the fuel-supplying and fuel-using industries, such as the steel industry, plant designing, and oil-chemical and coal-chemical, heavy and light chemical industries.

The following appointments have been made in the University Mr. R. W Douglas, at present a member of the Research Laboratories of the General Electric Co , Ltd , to the chair of glass technology in succession to Prof H. Moore, who is retiring , Dr. G. K. T Conn, senior lecturer, to be reader in physics , Dr Gilbert Forbes, senior lecturer, to be reader in forensic medicine , D Hardwick, to the C H Desch research fellowship in metallurgy , and Dr. N. M Waldron, to the research fellowship in chemistry offered by the Birmingham Chemical Co., Ltd.

Announcements

Her Majesty Queen Elizabeth the Queen Mother has been elected Chancellor of the University of London in succession to the Right Hon the Earl of Athlone

The Physical Society has made the following awards for 1955 *Charles Chree Medal and Prize,* Dr. D. F Martyn, chief scientific officer of the Radio Research Board, Commonwealth Scientific and Industrial Research Organization, Australia , *Duddell Medal,* Dr R Kompfner, of the Bell Telephone Laboratories, Inc. , *Charles Vernon Boys Prize,* Dr. J W Mitchell, reader in experimental physics in the University of Bristol

Dr. J. H. Watson has been appointed chemist and assayer of the Royal Mint in succession to Mr. W. A. C. Newman, who has retired.

Dr Rhodes W Fairbridge, lecturer in geology in the University of Western Australia, has been appointed professor of geology in Columbia University, in succession to Prof. A K. Lobeck, who has retired.

Three Ramsay Memorial Fellowships, normally tenable for two years and worth £450 a year plus a grant for expenses of research not exceeding £100 a year, are being offered for chemical research. One of the Fellowships will be limited to candidates educated in Glasgow. Further information can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1, to whom application forms must be sent not later than April 21

Two scholarships, tenable at research institutions in France during the academic year 1955–56, are being offered to British workers in medical science, excluding clinical medicine, by the Medical Research Council on behalf of the Centre National de la Recherche Scientifique. They are intended for young British graduates in medicine or science who have already had some experience in a branch of medical science, and are worth 50,000–70,000 francs a month, with a supplementary allowance, payable in sterling, for married men A working knowledge of French is essential. Application forms, to be returned by March 31, and further details can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

The Royal Dutch-Shell Group of Oil Companies is offering two research studentships in geophysics, of value £450 a year (£500 for married men) and tenable for two to three years at the University of Cambridge, which are open to men of any nationality less than twenty-seven years of age on October 1 Further information can be obtained from Mr. B C. Browne, Department of Geodesy and Geophysics, Downing Place, Cambridge, to whom application forms must be sent not later than June 1.

A Symposium on Intermetallic Semi-conductors will be held at the Services Electronics Research Laboratory, Baldock, Herts, during April 26–27 Further information can be obtained from I M Ross at the Laboratory.

The seventh of the international symposia on crop protection that are held in Ghent each year will take place on April 26, and will coincide with the quinquennial Floralias of Ghent Those wishing to read a paper must submit it before March 10 Further information can be obtained from the president of the organizing committee, Prof J. van den Brande, State Agricultural College, Coupure Links 233, Ghent.

The sixth Students Biological Conference will be held in the Biology Departments of the University of Birmingham during March 27–April 1. Undergraduate and postgraduate students are invited to read papers (not necessarily the outcome of original research work) and reviews , to exhibit collections , and to present demonstrations of field and laboratory work and techniques, etc. The programme will include a conversazione and visits to places of biological and general interest Further information can be obtained from the Conference Secretary, Botany Department, University, Birmingham 15

CO-OPERATION IN ENGINEERING RESEARCH BETWEEN EDUCATIONAL INSTITUTIONS AND INDUSTRY

A GROUP of three papers on co-operation in engineering research between educational institutions and industry was presented for discussion at a meeting of the Education Group of the Institution of Mechanical Engineers on January 28 The first paper of the group was by Prof E Giffen, of Queen Mary College, London, comparing the magnitude of the co-operation in engineering research in Britain and in the United States Estimates of the amounts of money contributed by government departments and by industry to support research in engineering departments of universities and colleges (either in general or on specific projects) showed that the expenditure in the United States is more than a hundred times the figure for Britain Taking the facilities available for research in terms of staff and laboratory accommodation as proportional to the numbers of full-time students, it appears that, if British educational institutions were used to the same extent as those of the United States for co-operation in research with industry (including government departments), our expenditure on this work would be increased more than ten-fold

Prof. Giffen mentioned some of the reasons for this disparity in the amount of co-operation in the two countries and suggested that the real difficulties lie in ignorance, both in industry and in the universities, of the other side's point of view, and that many of these difficulties could be cleared away by full and frank discussion by those concerned He went on to consider the desirable upper limit to co-operation in research, taking as criterion the benefit to the teaching work of a university department, the limit is reached when the staff are doing as much research as is consistent with their continuing to take an active and effective part in teaching. Although there is evidence that the amount of co-operation in some universities in the United States has passed this limit, we in Britain have a very long way to go before we need have any fear of that.

The second paper in the group, by Mr. V. C. Davies, was concerned mainly with engineering research in technical colleges in co-operation with industry. He stressed the opportunities for part-time research students to investigate problems encountered in the course of their work in industry. The time that can be devoted to the work is often much greater than that spent in the college, and the rate of progress can be surprisingly fast. Mr. Davies is of the opinion that special staff are necessary to supervise research, perhaps on a part-time basis, and special care is needed in selecting suitable subjects for research from those suggested by students from industry. Many of these suggestions are concerned with development of a particular machine or component, while some are better left to industry, others can be investigated jointly, the firm providing its own staff for parts of the work and the college undertaking the more fundamental aspects.

Mr Davies pointed out the opportunities for more sponsored research, and its benefits to both colleges and industry The question of publication of results need not cause any difficulty The main reason why more systematic research is not conducted by the teachers in technical colleges is their heavy load of teaching Until recently, all such teachers were, and many are still, required to spend about twenty hours each week with students, this, with the additional time taken in the preparation of lectures and the reading of students' work, left little time for research by the conscientious teacher Recent changes have enabled some of the larger technical colleges to reduce the amount of teaching required of the staff, and this should make a marked improvement in the opportunities for research

The third paper, by Mr J H. R Nixon, was written from the point of view of the small and medium-size organizations engaged in the manufacture of engineering equipment. The need for more research and development is becoming more widely recognized, and with it the desire for more co-operation with educational institutions. Sponsored or contract research is a suitable method for dealing with well-defined projects, with short-term or medium-term objectives, and where specific information is required which is beyond the company's resources In many cases it is found that the investigation of such special problems requires parallel research on fundamental lines, leading to results of general interest and with wide applications.

Mr. Nixon's experience has shown that the greatest benefit is derived if a member of the firm's staff participates in the work as it proceeds. The man might be seconded to work full-time in the university; apart from the results of the particular investigation, the experience is valuable and enhances his worth on his return to his firm But part-time participation can also be very successful, because then the man can apply the results of his research to improvements in design or production as the research proceeds. No better integration of research and development can be obtained than by organizing them to go on side by side, either by a team of workers or by a single man, depending on the nature of the project. In Mr. Nixon's opinion, firms are not sufficiently informed about the specialized facilities available to assist them with research and advice. Closer contact is desirable between industrial designers and development engineers and the staffs of universities and technical colleges One way of achieving this is through the use of professors as consultants on plans for research and development—a method much more extensively practised in the United States than in Britain

Dr. D. Clayton, who opened the discussion, emphasized the need for care in choosing suitable research problems as a basis for co-operation, and indeed in choosing all subjects for research students, to avoid wastage of man-power. Those concerned with new problems in industry should separate them into different categories according to the extent to which they involve fundamental work or practical techniques and then decide which could be investigated inside the organization, the others, mainly those involving fundamental studies, should be handed over to suitable university departments, establishments of the Department of Scientific and Industrial Research or industrial research associations.

Other speakers gave examples of the way in which co-operation in research has increased in recent years and of the benefits both to industry and to the university staff. Special mention was made of the close contact between the Ministry of Supply and university departments of aeronautical engineering and also of the Ministry's scheme for employing university teachers as vacation consultants. Suggestions were made for better methods of communicating information about the results of research, and about research in progress. Higher-degree theses are quite unsuitable for general publication, and the results should be re-written at different levels to suit the different kinds of readers to whom the results would be useful. It was suggested that abstracts of all higher-degree theses should be deposited with a central organization, such as the Department of Scientific and Industrial Research, which would bring the work to the notice of interested people.

Postgraduate courses for men in industry provide an effective research contact between industry and universities. The courses might be of long or short duration, but should include some experience in the investigation of problems relevant to the industry. On the other hand, it was pointed out that many of the students attending such courses, and indeed a large proportion of the students engaged on research for higher degrees, come from overseas countries, with the financial support of their governments, and will bring no direct benefit to industry in Britain. If industry were really convinced of the benefits of research and postgraduate courses as a training for its young engineers, it should send more of them back to the universities, either full-time or part-time; this in itself would be a valuable method of maintaining closer contact and promoting co-operation between industry and educational institutions.

AIRFLOW OVER MOUNTAINS

A DISCUSSION meeting was held on the subject of the "Airflow over Mountains" in the rooms of the Royal Meteorological Society on January 19. The subject poses an interesting problem in hydrodynamics, and also has implications of considerable importance to aviation; accordingly, many visitors having an interest in the aviation aspects attended. The discussion was opened by Mr. G. A. Corby, of the Meteorological Office, who gave a summary of the state of knowledge of the subject.

Stationary lenticular clouds can often be seen both over and to the lee of hills and mountains, strongly suggesting that systems of waves can be initiated in an airstream by topography. Cirrus clouds at 20,000 ft. or more, too, are believed to be due sometimes to the topography below; while over the Norwegian mountains so-called 'mother of pearl' clouds can be seen on rare occasions at some 70,000–80,000 ft. Clearly, the influence of mountains on the airflow above can be much more than an intensification of turbulence. Glider pilots have contributed much useful observational evidence of these special airflow effects, and their experience leads to a certain conception of what an atmospheric lee wave system is like. By exploiting the up currents in such waves, gliders have exceeded 15,000 ft. over hills of moderate size in Britain, while they have penetrated well into the stratosphere in the powerful wave systems of the Sierra Nevada in California. Powered aircraft also are affected by these vertical currents, which occasionally may be sufficiently intense to constitute a hazard. Aircraft flying over or near mountains sometimes pass through alternate regions of lift and sink; these regions may not be accompanied by any significant turbulence and, indeed, remarkable smoothness is sometimes reported. Vertical currents of a few hundred feet per minute are, apparently, quite common, while on extreme occasions smooth vertical currents exceeding 2,000 ft./min. have been encountered by aircraft in Europe.

The hydrodynamical problem of the laminar, frictionless and isentropic flow over an idealized two-dimensional ridge has been studied by several workers, using perturbation theory. Prof. P. Queney confined himself to a uniform airstream, that is, one in which the static stability and wind in the undisturbed stream were constant, and found that the nature of the flow depended very much on the scale of the problem. For a very small hill, neither stability nor geostrophic forces were relevant, and his solution gave a single smooth disturbance over the hill. For a hill of a few kilometres in width, the stability became important, and a more complicated disturbance affected the flow above the hill throughout the depth of the airstream. For a large mountain ridge of about 100 km. in width, his solutions predicted a lee wave system. On examination, this wave system proves to be mainly a horizontal oscillation about the geostrophic wind, having a long wave-length of some hundreds of kilometres. Although such waves probably occur in the atmosphere, they cannot be responsible for the vertical currents which embarrass aircraft and are exploited by gliders.

In Dr. R. S. Scorer's theoretical work, provision was made for variations of static stability and wind in the vertical. A certain function of the wind and stability proved to be a parameter of fundamental importance in the problem, and Scorer has shown that for realistic lee waves to be possible in an airstream, a decrease in this parameter with height is necessary. The condition can be fulfilled in practice by the presence of a layer of marked stability (or an inversion) at middle levels, with less stable air above, or by a substantial increase in wind with height, or by some combination of these two effects. Perturbation theory calculations for the flow of such an airstream over a mountain predict a system of lee waves which accords well with observational data. The waves have a wave-length of a few kilometres, and after attaining a maximum amplitude at some level, they die away at greater heights, sometimes slowly, sometimes quickly. An example of the theoretical streamlines calculated for a particular case is given in Fig. 1; the relevant temperature and wind profiles are indicated at the left of the diagram. Examination of the characteristics of the airstreams in which mountain waves have been encountered by aircraft shows that the conditions are consistent with those deduced theoretically by Scorer. The theory could be exploited qualitatively for the preparation of advice to aviation interests; but it would be difficult to apply the theory with any precision because of the complications of the atmosphere and of mountainous terrain in general.

Dr. J. Forchtgott, an expert Czech mountain glider pilot, has carried out a series of field investigations over several mountain ridges of Central Europe, using teams of gliders, light aircraft and special ground observations. He found that no organized pattern of airflow could be discerned unless the airstream had stable or neutral stability, and the wind direction was fairly constant with height and

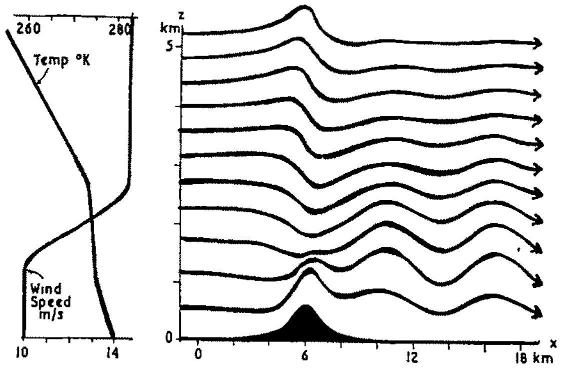


Fig 1 Theoretical stream-lines for the flow over a mountain ridge under conditions favourable for lee waves

roughly perpendicular to the mountain ridge. Subject to these conditions, the type of flow depended on the wind For moderate winds, a large semi-permanent standing eddy was often observed in the lee, with reversed flow up the lee slope. With stronger winds increasing with height, a lee wave system developed, often with lenticular (wave) clouds aloft and rotating clouds in the wave crests at heights comparable with that of the mountain top With very strong winds extending through a restricted vertical depth, that is, when, above the friction layer, there was reversed wind shear in the vertical, Forchtgott found that heavy turbulence occurred, due, he believed, to the formation of a system of vortices rotating in opposite directions and having features similar to the Kármán vortex street of hydrodynamics He named the latter flow type 'rotor streaming' Theory can as yet make no predictions as to the nature of such non-laminar flow patterns.

Mr. A. Yates described more recent work by Dr Forchtgott in which he has elaborated his diagnosis of the flow types From observations of lenticular clouds he has concluded that mountain waves sometimes move slowly downstream, to be followed sometimes by apparent rapid movements upstream. During the course of the meeting it was suggested that complicated interference must occur between the wave trains from separate orographic features, and this, coupled with random or systematic changes in the airstream characteristics, might well account for apparently erratic changes in the wave-length and amplitude of atmospheric wave systems

Mr C E Wallington gave an account of a calculation of the flow over a section of the Derbyshire countryside on an occasion when a marked wave system was encountered during a glider flight A close approximation to the topography was achieved using five Fourier integrals, and the profiles of static stability and wind were obtained from meteorological upper air data Synthesis of the five flow patterns obtained by perturbation theory gave the theoretical flow over the actual topography A useful measure of agreement between the observed and calculated flows was demonstrated

Prof G. Manley described some observations of the striking wave phenomena which sometimes occur with strong easterly winds over the Crossfell escarpment in Cumberland The question of separation of the flow and the formation of eddies was discussed by Dr R. S Scorer, who demonstrated the part played by viscosity in encouraging eddy formation Katabatic winds and such effects would discourage eddies , but on the whole it appeared, that the shape and steepness of the lee slope were the most important factors in determining separation Such effects near the surface could have a profound effect on the flow at much greater heights, because the effective shape of a hill becomes completely changed by the presence of a lee eddy

Research into the possibility of exploiting wind-power for the generation of electricity has stimulated the collection of wind data from hill tops in Britain Mr H H Rosenbrock reported that an increase of up to 40 or 50 per cent in wind speed is to be expected over hill crests, and as the power available from wind varies as the cube of the speed, the increase is important. In the case of a long ridge, the increase in speed arises from the compression of the stream-lines over the crest , but a similar increase is also attained over an isolated hill because much of the flow at low levels passes around the hill, and accordingly the crest-level flow is derived from a higher level

Mr K W. V Townsend discussed the distribution of tree damage from gales in hilly country Although this is complicated because of the variation of tree growth with altitude and soil properties, nevertheless the distribution was clearly dominated by the local distortion and intensification of the wind-flow by the terrain

The closely related subject of orographic rainfall was discussed by Mr J S. Sawyer, who pointed out that rainfall totals over 12 or 24 hr. were on much too coarse a time-scale to reveal the effects on rainfall of complicated and changing atmospheric waves However, it was clear that the increase in rainfall over hilly terrain was often significant to the lee as well as over the crests and windward slopes He had noted also that the increase was commonly much more marked to the south of depression tracks than to the north , an explanation could be that the wind structure to the south (normally an increase with height) would be more favourable for orographic disturbances to the airstream than to the north (where there would normally be reverse wind shear).

Mr H. S Turner put forward the suggestion that there might be an association on some occasions between high-altitude clear air turbulence, sometimes encountered by high-flying aircraft, and topography. The idea is gaining favour, and Dr Scorer has pointed out that mountain waves could provide the mechanism for the generation and maintenance of the large shears of wind which appears to be necessary for such turbulence

Some pilots of British European Airways described their experiences in flying through mountain waves and turbulence, and Mr R K. Pilsbury, of the meteorological office, Northolt Airport, gave brief details of an analysis of such aircraft observations.

G A. Corby

THE BRITISH COUNCIL

ANNUAL REPORT

APART from the chapter dealing with the welfare of overseas students, the portions in the report on the work of the British Council for the year ended March 31, 1954*, of most direct interest to the scientist are those discussing university interchange and the written and recorded word.

---

* Report on the work of the British Council for the year ending 31st March 1954 Pp v+105 (London British Council, 1954) 2s 6d.

The value of the work of the Council on university interchange was acknowledged at the Seventh Congress of the Universities of the Commonwealth in July 1953, and for the development of such services the Council depends largely on the co-operation of the universities and on the advice of its Universities Advisory Committee. Details of the interchange service with thirteen European countries, whereby during each academic session the British universities invited fifty-four distinguished scholars to Britain and in return a similar number of invitations were extended to British university teachers for the period 1948–53, have already been given

The Anglo-Belgian Mixed Commission has recently suggested that some of the younger university scientists who are doing original work of particular interest might profit from the opportunity of consultations overseas with research workers in their own fields of study Such interchange visits have already been arranged between the United Kingdom and Belgium, and it is hoped to extend the scheme to younger university scientists in other countries. More than a hundred scholarships tenable in the United Kingdom are now offered annually by the British Council to students from other countries, and a like number are offered to British students for study in fifteen European countries Among the short visits for consultation and lectures under the Commonwealth scheme for which awards were made during the year are those of Prof. P. A Giguère, of Laval University, to the United Kingdom, of Dr. F. C. Phillips, of the University of Bristol, to Australia, and of Sir Arthur Carr-Saunders to South Africa Thirty-six awards were made for study in the United Kingdom and twelve for study in other Commonwealth countries Under the foreign visits scheme, 31 awards were made for short visits from twelve countries to United Kingdom universities, and 43 awards for visits to universities in ten foreign countries

It is an essential part of the Council's work to use books and periodicals as extensively as its funds permit Export figures of English periodicals are unknown, but the annual export trade in books exceeds £14 million and nearly half the books published in Britain go overseas But there are important countries which can find no sterling for the purchase of British publications, and others have few or no competent booksellers, in some areas the British trade has not yet established itself The British Council libraries may thus be the only sources from which would-be readers of English can meet their needs. The Council's work is concerned first with publicity chiefly for new British work of all kinds, including book exhibitions, the forwarding of books for review, and the issue of the *British Medical Bulletin*, *British Book News* and the *British Agricultural Bulletin* Each issue of the first of these deals with a single aspect of medical science, the subjects covered in 1953–54 being enzyme research, viruses in medicine, reactions to injury and tuberculosis A second department deals with the supply of printed matter to libraries, schools and other institutions, and also with requests for bibliographical information. During the year, the small increase in the grant for books had surprisingly effective results, but annual replacements of about five per cent of stocks are still below the fifteen per cent required Thirdly, the Council's work in this field includes the production of publications such as the supplements to *British Book News* on "Writers and their Work", "English Language Teaching" and "Britain To-day", which has been discontinued since the report was prepared

Although the Drogheda Committee presented its report on overseas information services in July 1953, the summary of the report was not published until April 1954, nor has the Government even yet made known its intentions. That report emphasized that what the British Council requires more than anything else is a five-year programme of developments, with some guarantee that the necessary funds would be provided for its execution. In particular, directing attention to the great opportunities which await the Council in Asia and Africa, the report recommended an eventual increase of about £630,000 a year in the Council's vote

In the uncertainty as to whether the Government is prepared to accept any of the recommendations of this report, the Council has already been forced to make economies in its work in Europe, but it has been allowed to retain the proceeds and to re-invest them in work elsewhere, while some additional money has been granted to meet the Council's rising operating costs. On the question of this contraction of its work in Europe, however, the Council has some misgivings It gives reasons for believing that in detail the Drogheda Committee over-estimated the extent of the savings to be achieved by further curtailing that work (which has already been cut by fifty per cent over the past five years) More important, it questions the attitude to Europe disclosed in the report and is doubtful whether it is wise to rely solely on casual contacts in the face of a manifest anxiety for increased British cultural activity and co-operation in Europe

While recognizing the greatness of its opportunities and responsibilities in Europe, the Council remarks "It would be an exaggeration but not an untruth to say that a much closer understanding of the Englishman and his ways exists at Karachi than at Lyons, partly because Englishmen are a more familiar sight in one city than in the other, and partly because an outward similarity of culture helps to mask a basic difference of mental approach". The Council believes that the Drogheda Committee has misconstrued the importance of the work in Europe, because it has failed to appreciate that the Council's work has an element of disinterestedness as well as a representative aspect The Council exists as a body which helps to interpret overseas the permanent features of the British way of national life and to make available to the rest of the world the British contribution to knowledge, welfare or enjoyment If, however, the Council is always to aim at producing a definable political or commercial benefit for the country, it will lose the advantage it possesses over a government information department

It is a sound point that the British Council must sometimes do something for its clients simply because it is what the client wants, unless the idea is to grow that there is always a material motive behind its activities The point should not be pressed too far, but it is political wisdom that an independent body should not neglect its opportunities of disinterested service. In Europe, in Africa and in Asia alike, such a policy may yield rich returns in international goodwill and understanding.

Apart from these comments, the Council welcomes the Drogheda report, while expressing the reasonable hope that the stage of repeated major investigations (of which the Drogheda inquiry was the third in seven years) has been passed The Drogheda report has established beyond question the national importance of the Council's work and the efficiency with which it is carried out. It has also established the importance of continuity of planning and finance, and of stable and secure conditions of service To implement the recommendations to that end would be comparatively inexpensive and is imperative, irrespective of whether or not the Government is prepared to provide the additional resources which would enable the Council to seize the opportunities in Asia and Africa, the reality of which is amply confirmed in the present report

Since the report was published, the Government has stated in the House of Commons that it proposes to provide an additional £100,000 in the present and next financial years for the expansion of the overseas information services In particular, it is proposed to strengthen the information services in South-East Asia, the Middle East, Latin America and Canada, to improve the Central Office of Information Press Service and the supply of films for use overseas, to strengthen the Council offices in South-East Asia and Japan, establish new offices in Kuwait in the Persian Gulf and in British Honduras and re-open an office in Persia Full participation by the Government in the growing cultural activities of the Brussels Treaty Organization and of the Council of Europe is also proposed

PHYSIOLOGY OF STOMATA

THE seemingly evergreen topic of the physiology of stomata has evoked a number of further contributions by contemporary investigators M Shaw and G. A Maclachlan (*Canad J. Bot*, **32**, 6, 784, 1954) have studied the carbon dioxide fixation in stomatal guard cells By exposing the epidermis of species of *Tulipa*, *Hordeum*, *Tradescantia* and *Allium*, in which only the stomatal guard cells possess chlorophyll, to radioactive carbon dioxide, followed by microautoradiography, they have demonstrated the selective uptake of carbon dioxide by the guard cells in the light A less intense uptake was observed in the dark with *Allium*, *Sedum*, *Tulipa* and *Vicia* The rate of guard-cell synthesis, which was estimated for *Tulipa gesneriana*, appeared to be too low to account for the increase in osmotic potential caused by illumination. These investigators note that since the opening of stomata is promoted by low carbon dioxide tension, even in darkness, the removal of free carbon dioxide, or an effective lowering of its tension, by guard-cell activity, is probably more important in stomatal opening than the direct photosynthesis of osmotically active solutes in the guard cells

In a new theory of the mechanism of stomatal movement, W T Williams (*J. Exp Bot*, **5**, 15, 343; 1954) advances the ideas that the important movement is that of closure, that this is a positive or active process, and that the carbohydrate changes so frequently reported are secondary, 'stabilizing' changes, probably not directly linked to the main process The evidence for this conception of stomatal activity is discussed and some of its implications considered It is accepted that stomatal movements are primarily the result of turgor changes In expounding the theory the author directs attention to the many remarkable parallels between the movements of sensitive plants and of stomata. Reference is made to Weintraub's explanation of pulvinar movement in *Mimosa*, in which it is held that the rapid expulsion of water from the cells of the pulvinus is effected by way of contractile vacuoles, and to the movement of water in protozoa and unicellular algæ. In these micro-organisms this water movement is energy-assisted—a process which allows for the movement of water as distinct from solution, independent of osmotic gradients To quote the author on the subject of stomata: "If dark induced loss of turgor is an energy-assisted process, how, during the ensuing hours of darkness, is it maintained? Must water be continuously pumped out to maintain the flaccid condition? It would appear so for the theory postulates that the turgid condition is osmotically the position of rest, to which the cell must return if contractile forces are withdrawn—as occurs in light, or even, in response to an autonomic stimulus, in the unchanging darkness".

E. W. Yemm and A. J. Willis (*New Phyt.*, **53**, 3, 373, 1954) have made a study of the diurnal movements of the stomata of *Chrysanthemum maximum* by means of porometer measurements of leaf resistance and by examination of epidermal strips The amounts of sugar and starch in the epidermis and mesophyll were estimated. A highly significant correlation was demonstrated between the starch content of the guard cells and pore-width or leaf resistance. The opening of stomata in the morning was associated with a decrease in starch and an increase of sugars in the epidermis together with a fall in the water content of the leaf. The stomata closed when the water deficit exceeded 5 per cent of the water content of the fully turgid leaf The closure was associated with an increase of starch in the guard cells, but there was no corresponding fall in the sugars of the epidermis The total carbohydrates of the epidermis showed a distinct diurnal fluctuation which was in some respects like that of the mesophyll. In the light of this investigation the authors suggest that the diurnal movements of these stomata under natural conditions are mainly determined by the water relations of the leaf tissues and carbohydrate changes in the guard cells.

AN EXPERIMENT ON THE INHIBITION OF THERMAL CONVECTION BY A MAGNETIC FIELD

By Dr YOSHINARI NAKAGAWA

Hydrodynamics Laboratory, Department of Meteorology,
University of Chicago, Chicago

THE character of the thermal instability of a layer of incompressible liquid heated from below has been the subject of both experimental and theoretical investigation since Benárd's[1] discovery of cellular convection in those circumstances. The principal results established by these investigations are: (1) that a layer of fluid heated below first becomes unstable when the Rayleigh[2] number, $R = \frac{g\alpha\beta}{\kappa\nu} d^4$ (where g denotes the acceleration due to gravity, d the depth of the layer, β is the adverse temperature gradient which is maintained and α, κ and ν are the coefficients of volume expansion, thermometric con-

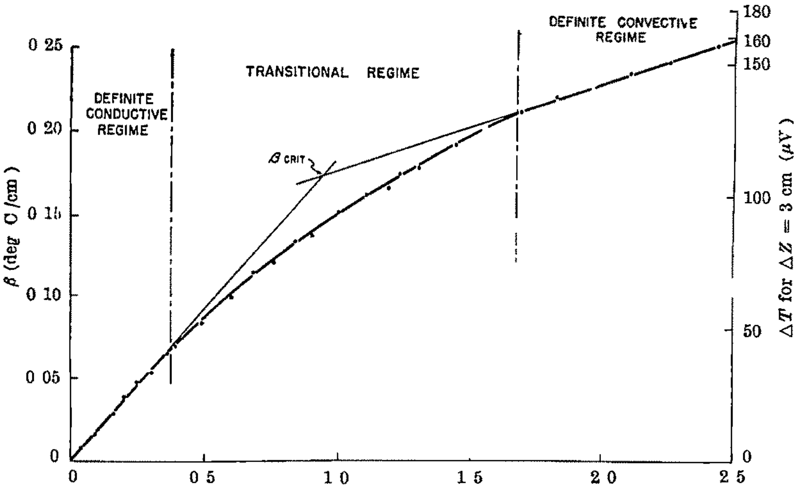


Fig 1 Temperature gradient at various rates of heating Experimental points are for temperature gradient measured at 1 cm and 4 cm levels in 5 cm depth of mercury Average magnetic field around central plane, 1,500 gauss

$$R_c = \frac{\alpha\beta_c g}{\kappa\nu} d^4 = 3·82 \times 10^5, \quad Q = \frac{\mu^2\sigma|H|^2}{\rho\nu} d^2 = 3·37 \times 10^4$$

ductivity and kinematic viscosity, respectively), exceeds a certain determinate value of the order of 1,000, and (2) that the motions which ensue have a cellular pattern in agreement with Benárd's observations The exact value of the Rayleigh number at which instability first sets in depends on boundary conditions, such as whether the plane surfaces between which the layer of fluid is confined are free or rigid (cf Jeffreys[3] and Pellew and Southwell[4]), and the values which have been derived theoretically have been confirmed by several experimenters[5,6]

Chandrasekhar[7] has recently re-examined this problem for the case of a layer of electrically conducting liquid heated from below and when an external magnetic field is impressed on the liquid. The principal result of his study was to establish that the presence of the magnetic field delays the onset of convection, and that the critical Rayleigh number at which instability sets in depends on the strength of the magnetic field (H) and the electrical conductivity (σ) of the fluid through the non-dimensional parameter $Q = \frac{\mu^2 H^2 \sigma}{\rho\nu} d^2 \cos^2\vartheta$, where μ denotes the magnetic permeability of the liquid and ϑ the inclination of the direction of H to the vertical. In his paper, Chandrasekhar has derived the $R(Q)$-relation for different boundary conditions (for example, both bounding surfaces rigid, both bounding surfaces free and one bounding surface rigid and the other free)

The experiments to be described below were designed to investigate the critical values of the Rayleigh number predicted by Chandrasekhar for different values of Q with mercury as the electrically conducting liquid The external magnetic field was provided by a permanent magnet used originally as the deflexion magnet for cosmic ray experiments and very kindly made available for this experiment by Prof Marcel Schein, of the Physics Department, University of Chicago

Mercury contained in a 'Pyrex' glass cylinder of 14·5 cm diameter was placed at the centre between the pole surfaces, the magnet being placed so that the field was vertical The average intensity of the magnetic field over the area of the glass cylinder at the central plane of the gap was about 1,500 gauss Uniform heating was applied by an electrical heater with d c current beneath a copper plate at the bottom of the cylinder A combination of sliding resistances was used to obtain various rates of heating, and to provide the relation between temperature gradient and the heating-rate as mentioned below

The quantities, except β, in the Rayleigh number and Q were given constants at each determination, and the criterion was investigated by means of the experimental determination of the critical adverse temperature gradient. The adverse temperature gradient was measured directly in this experiment by means of a five-couple copper–constantan thermopile immersed at two fixed levels in the mercury. The thermal e m f of the thermopile was amplified by a d c amplifier and recorded in an automatic recording milliammeter A continuous record of the temperature gradient was obtained within an accuracy of 0·01 deg C. for the total temperature difference between the two fixed levels

The temperature gradient was plotted against the heating-rate and the critical temperature gradient was determined from the intersection of the extrapolated linear trends of the pure conductive region and the pure convective region of heat transfer[8]. Fig 1 shows the experimental results for a 5-cm layer of mercury. The regions of heat transfer indicated

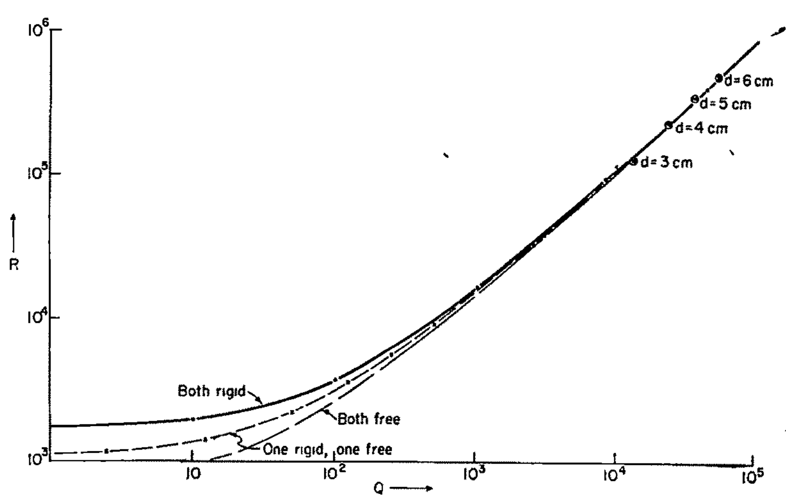
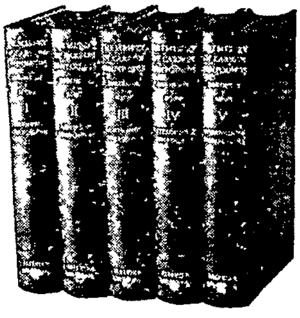


Fig 2 Dependence of the critical Rayleigh number on Q The curves are Chandrasekhar's theoretical curves, the experimental results are marked by circles, the depth of mercury used in each case being indicated

★ **Aromatics** *in Volume III: Part A (of 2) ready late in April*

Chemistry of Carbon Compounds

Edited by E H RODD, D Sc, F R I C



Some of the 9 bound parts
Crimson cloth, 9 in. × 6½ in

THE masterly general survey which opens Part III (A) is by Prof C K. INGOLD (on views about structure, orientation and reactivity), Prof G H HEY and Dr G H WILLIAMS (on nucleophilic and homolytic substitution) and Dr N CAMPBELL (on the formation and fission of the benzene ring). Dr W J HICKINBOTTOM, DR Z E JOLLES, DR J CHATT, and Dr. E HOGGARTH cover most of the benzene derivatives, which will be completed in Vol III (B) along with pseudo-aromatic and multi-nuclear compounds

If pre-ordered
£5 5s.
After pub., £5 15s.

The 9 parts of this magnificent reference set will cost some £40, but 15% is saved on any ordered before publication Write to 31, Wright's Lane, London, W 8, for folder with specimen pages and authoritative reviews, or visit your scientific bookseller

An Elsevier Reference Book from Cleaver-Hume Press Ltd.

McGRAW-HILL LONDON

Servomechanism Practice

WILLIAM R AHRENDT, *President of the Ahrendt Instrument Company Lecturer, University of Maryland*

This text provides in compact form a clear and logical treatment of the practical aspects of servomechanisms Whereas other books are primarily concerned with the theory of the subject, this work covers circuitry, electrical and mechanical components, and practical problems encountered in servo design and manufacture

9 × 6 inches 341 pages Illustrated 50s

Chemical Calculations 6th edition

HAROLD V ANDERSON, *Lehigh University*

This book is primarily designed to assist the chemistry student in understanding the mathematical applications of the many fundamental principles of elementary and general chemistry

The sixth edition contains numerous important changes and additions

9 × 6 inches 305 pages 34s

Higher Transcendental Functions

A ERDELYI, *California Institute of Technology*

"This work is a worthy tribute to the memory of an outstanding mathematician and its great importance as a major work of reference hardly needs emphasis"—*Engineering*

"No university or scientific library will be complete without having these volumes on its shelves."—*Nature*

Vol 1	9 × 6 inches	328 pages	49s
Vol 2	9 × 6 inches	400 pages	56s 6d

New and forthcoming books

Embryogenesis in Plants

C W WARDLAW
Professor of Cryptogamic Botany, University of Manchester

In this book, the first botanical treatise of its kind, the author has examined the process of embryogenesis in all classes of plants, from Algae to Angiosperms The basic anatomical facts of embrvo development are described and profusely illustrated, and recent experimental work, relating to the actual processes involved, has been introduced wherever possible.

With 84 line illustrations. 42*s*

The Nitrogen Metabolism of Micro-Organisms

B A FRY
Lecturer in Microbiology, University of Sheffield

(Monographs on Biochemical Subjects)

This monograph provides a convenient introduction to one important section of microbial biochemistry The underlying theme is none other than that known to all biologists as the 'Nitrogen Cycle,' and an attempt has been made to analyse some of the component steps of the cycle from the standpoint of the biochemistry of the various reactions and the micro-organisms concerned

With 3 plates and 15 diagrams 9*s* 6*d*

Photosynthesis

ROBERT HILL, F R S, and
C P. WHITTINGHAM, Ph D

(Monographs on Biochemical Subjects)

A concise but comprehensive survey of current research in Photosynthesis, dealing first with the earlier classical work on the physiology of photosynthesis and then discussing the relevant basic biochemical aspects of the subject

With 20 diagrams 8*s* 6*d*

Mass Spectrometry

A J B ROBERTSON
Lecturer in Chemistry, University of London, King's College

(Monographs on Chemical Subjects)

"The book is well written, the treatment is interesting and authoritative, the diagrams are clear, and many references are given for further reading It will be of interest to a wide circle of readers, including students, teachers and research workers" *Chemical Age*

With 2 plates and 26 diagrams 8*s* 6*d*

METHUEN

INTRODUCTION TO

Tensors, Spinors and Relativistic Wave-Equations

(Relation Structure)

E M CORSON, Ph D.

This book consists of two parts—Mathematical Foundation and Physical Principles There is an extensive Bibliography

55*s*

Theory and Application of Infinite Series

Dr KONRAD KNOPP
Professor of Mathematics,
University of Tubingen

Translated from the *Second German Edition* and revised in accordance with the Fourth

Second Edition. 45*s.*

BLACKIE & SON, Ltd.

Enquiries to 17 STANHOPE STREET, GLASGOW, C.4

The International Union of Biological Sciences has still a limited number of copies available of.

INDEX DES ZOOLOGISTES
(1953)

comprising three lists : one of persons, a second by countries and a third by specialties Price 3,000 F.F.

INDEX DES GENETICIENS
(1953)

comprising two lists : one of persons, the other by countries. Price 1,200 F.F.

Send orders to :

Union Internationale des Sciences
Biologiques,
Publication Office (Prof. R. Ulrich),
1, rue Victor Cousin,
PARIS (5e), FRANCE

MACMILLAN BOOKS

Comprehensive Inorganic Chemistry

Edited by M CANNON SNEED, J. LEWIS MAYNARD and ROBERT C BRASTED

Volume III—The Halogens, by ROBERT C BRASTED

Comprehensive Inorganic Chemistry is an eleven-volume reference work on the chemical elements and their inorganic compounds In this Third Volume the significant advances of recent years are fully reflected in a broad treatment of halogen chemistry Both basic principles and their applications are exhaustively covered, as well as the new processes, methods of production, and the chemistry of compounds which have lately become so important 35*s.*

General College Chemistry

Edited by M CANNON SNEED, J LEWIS MAYNARD and ROBERT C. BRASTED

Rapid developments in chemistry during the post-war period have made a thorough revision of the first edition necessary, especially in those areas dealing with atomic structure, nuclear reactions, and industrial chemistry The text has been shortened, and a more systematized treatment has been introduced *Second revised edition.* 48*s.* 6*d.*

Advanced Level Examples in Physics

R. V. JOHNS, M A., B.Sc.

Lecturer in Physics and Mathematics, City of Liverpool College of Technology

W. F WARE, B Sc , A.Inst P

Senior Physics Master, Cathays High School for Boys, Cardiff

This book of numerical examples is designed to supplement the theoretical and laboratory work of students preparing for examinations in Physics at the Advanced level of the General Certificate of Education and for Intermediate Degree examinations. Some 1,000 examples have been arranged by topics and carefully graded in difficulty. Contents are arranged under the headings Mechanics and Properties of Matter, Heat, Light, Sound, and Magnetism and Electricity 16*s.*

Functions of a Complex Variable

THOMAS M. MACROBERT, M.A , D.Sc.

Professor of Mathematics in the University of Glasgow

This book is designed for students who, having acquired a good working knowledge of the calculus desire to become acquainted with the theory of functions of a complex variable, and with the principal applications of that theory In order to avoid making the subject too difficult for beginners, the author has abstained from the use of strictly arithmetical methods *Fourth Edition.* 20*s.*

All prices are net

St. Martin's Street, London, W.C.2

REALLY NEW

THE LOW INERTIA WARBURG APPARATUS

★ CHEAPER ★ MORE COMPACT ★ SILENT

BRITISH INSTRUMENT INDUSTRIES EXHIBITION
EARLS COURT LONDON
June 28 - July 9. 1955

Takes normal manometers and flasks

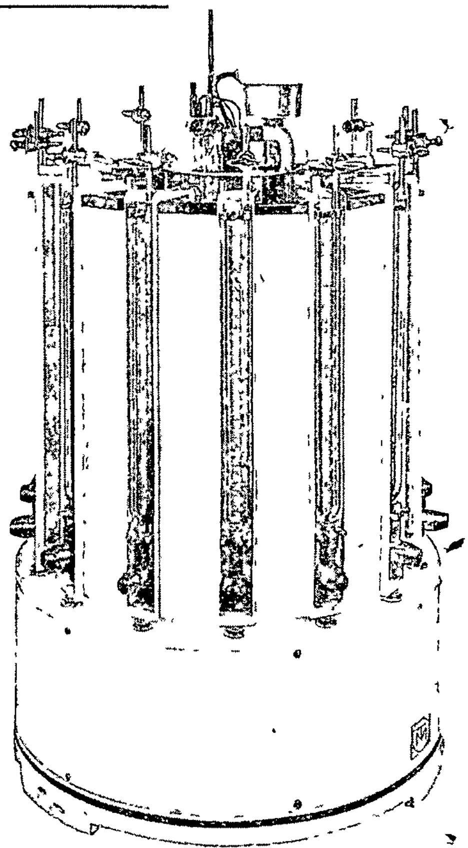
Every manometer shakes (*individually*) with a sprung semi-rotary movement and can be arrested for reading by gripping it

Every manometer can be brought opposite the operator

Temperature ± 0 01° C at 37° C.

– FOR – *"Service to Science"*

TOWNSON & MERCER LTD.
CROYDON *phone THOrnton Heath* 6262 ENGLAND

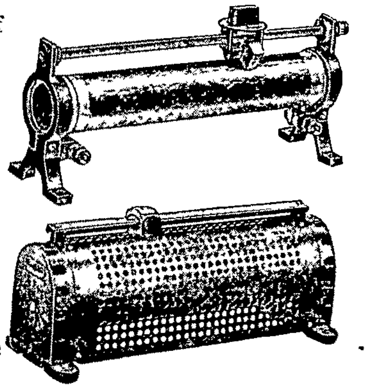


ZENITH
(REGD TRADE-MARK)

TUBULAR SLIDING RESISTANCES

Zenith Resistances of proved durability are in constant satisfactory use in all parts of the world They are available in a great variety of types and sizes, and are ideal for use in laboratories and test rooms

Illustrated catalogue of all types free on request



The ZENITH ELECTRIC CO. Ltd.
ZENITH WORKS, VILLIERS RD, WILLESDEN GREEN
LONDON, N W 2
Phone WILlesden 6581-5 *Grams* Voltaohm, Norphone, London
MANUFACTURERS OF ELECTRICAL ENGINEERING PRODUCTS
INCLUDING RADIO AND TELEVISION COMPONENTS

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE
FROM LIVER OR YEAST
and other SIGMA brand products are now available
Ask for list SIGMA 8
GEORGE T. GURR LTD.
136-138 NEW KINGS RD, LONDON, S W 6
The Microscopical Stain People

HARRINGTON BROS. LTD.
4 OLIVER'S YARD, 53a CITY ROAD, LONDON, E C.1
Telephone Clerkenwell 3807 (2 lines) Telegrams "Siccative, Ave, London"
LABORATORY CHEMICALS
Specialists in the supply of Organic and Inorganic Chemicals for use in
SCHOOL LABORATORIES Reagents, Indicators and Volumetric Solutions, Stains and other Materials for Microscopy
Catalogue sent on request

POLAROGRAPHY

The 'Electrochemical Laboratories' Manual Polarographs are designed for plotting polarograms with ease, speed and accuracy

MODEL A. For the analysis of solutions of moderate concentrations

MODEL B MK II. For all polarographic work in industry and research

HYDROGEN GENERATOR. D C Power Supply and Electrolytic Cell, giving 2,000 c c H_2 per hour

Full details on request

ELECTROCHEMICAL LABORATORIES
5, Highfield, Wardle Road, Sale, Manchester.
Tel. Sale 5851, 6529

ANTWEILER Micro Electrophoresis Apparatus

WITH SCHLIEREN OPTICAL CONTROL ATTACHMENT

A compact instrument for the quantitative analysis of serum proteins combining maximum accuracy with speed and simplicity of operation

★ **Effective protein separation within 15 to 20 minutes.**

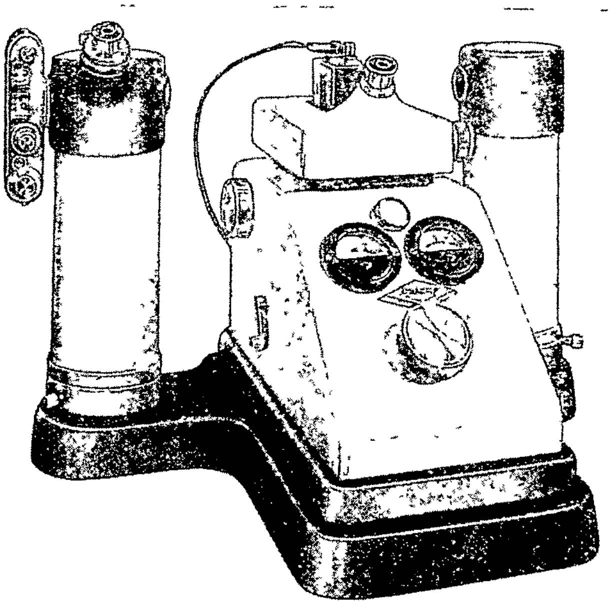
★ **Only 60 to 90 minutes required for a complete quantitative analysis giving consistently accurate and comparable data.**

★ **The progress of separation can be viewed continuously, and a distinct Schlieren Picture is formed after only a few minutes run**

The last feature makes the instrument particularly valuable for rapid routine clinical examinations

Please write or telephone for further particulars

SHANDON



SHANDON SCIENTIFIC COMPANY LTD., 6a CROMWELL PLACE, LONDON, S.W.7

• **Individually Tested and Guaranteed** •
(A E R E Harwell approved)

HIGH VACUUM STOPCOCKS

New Catalogue on request to

G. SPRINGHAM & CO. Harlow New Town

"The Stopcock People" HARLOW 24108

BRASS • COPPER • DURAL • ALUMINIUM • BRONZE •
ROD, BAR, SHEET, TUBE, STRIP, WIRE
3,000 STANDARD STOCK SIZES
No Quantity too small • *List on application*
H. ROLLET & CO., LTD.
6, CHESHAM PLACE, LONDON, S W 1 SLOane 3463
Also at LIVERPOOL, LEEDS, MANCHESTER, BIRMINGHAM

The SCIENTIFIC BOOK SUPPLY SERVICE
(T FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

MEDICAL RESEARCH COUNCIL

The Separation of Protein Fractions from Human Plasma with Ether

BY R A KEKWICK AND MARGARET E. MACKAY

Procedures are described in this report for the preparation in pure form of these biologically important substances

Special Report Series No 286 6*s* (6*s* 2*d*) [$1 40]

Indices of Heat Stress

BY F E SMITH

This report on the advantages and disadvantages of two different indices of warmth will interest all concerned with the wellbeing of workers in hot conditions

Memorandum No 29 2*s* (2*s* 1½*d*) [50 c]

Prices in brackets include postage, dollar prices are post free in the U S A

Obtainable from

HER MAJESTY'S STATIONERY OFFICE

P O Box No 569, London, S E 1, Edinburgh, Manchester, Birmingham, Cardiff, Bristol, Belfast, or through any bookseller, and from British Information Services, 30, Rockefeller Plaza, New York 20, U S A

Diffraction Gratings

We have now undertaken the manufacture under licence of diffraction gratings by the "N.P.L./Merton" processes

These processes have been developed over the past six years by the National Physical Laboratories and are capable of producing high quality gratings at a lower cost than by the older methods of manufacture.

A specimen of our present production is:—

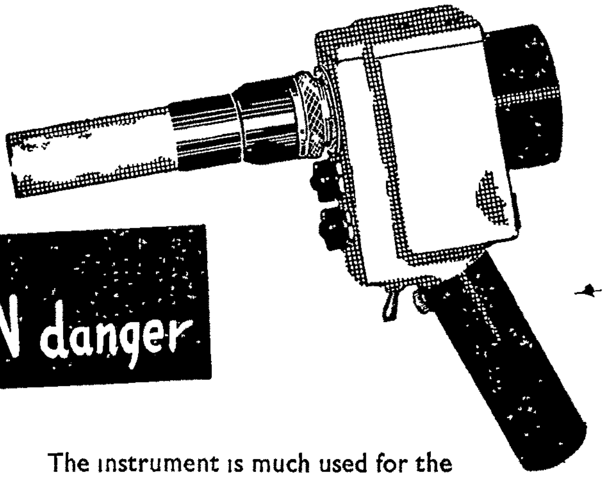
Grating 3″ x 3″ nominal on ½″ glass plate Price £6 . 15 . 0

Paton Hawksley

ROCKHILL LABORATORIES, KEYNSHAM, BRISTOL, KEYNSHAM 2364

STATIC

an UNSEEN danger

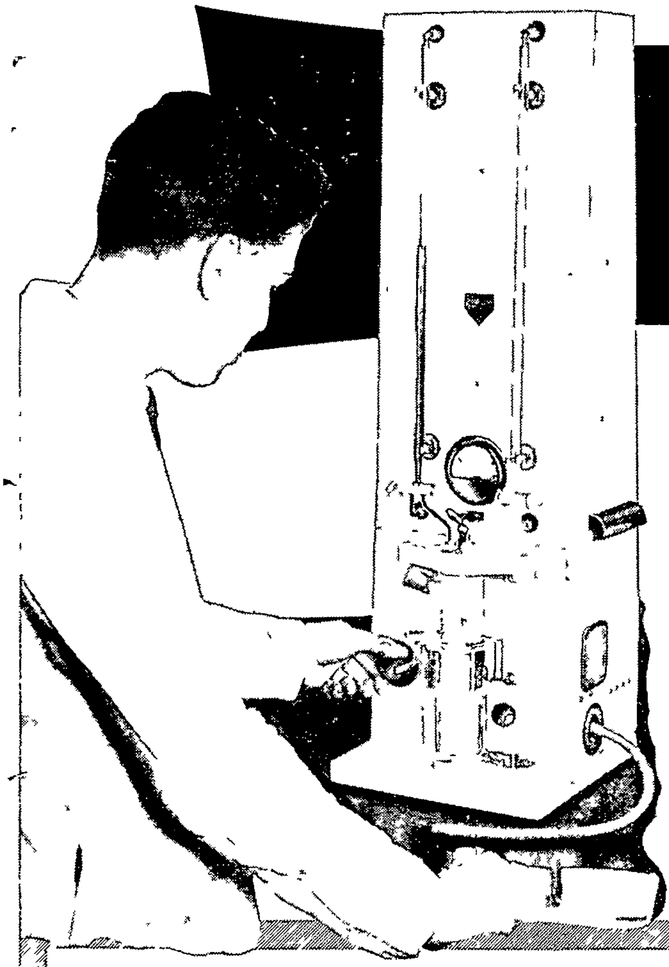


The Statigun measures potential gradient in air over the range 0-300kv/ft Attachments enable insulation resistance up to 10^{13} ohms and surface charge density up to 3×10^{-9} coulombs/cm^2 to be measured.

The instrument is much used for the investigation of static charges in the textile, plastics, paper, rubber and explosives industries as well as in hospital operating theatres. Further details are given in leaflet No. F.123 available on request.

BALDWIN scientific instruments

BALDWIN INSTRUMENT COMPANY LTD DARTFORD KENT • TEL 2948



BTL

INSTRUMENTS IN ACTION

BTL Electrometric Apparatus for KARL FISCHER TITRATIONS

The apparatus is here seen in the laboratories of Messrs Parke, Davis & Co Ltd Besides applications in the pharmaceutical field it has been found of great value in the control of production of sugar, confectionery, industrial starch products, oils, solvents and many other materials

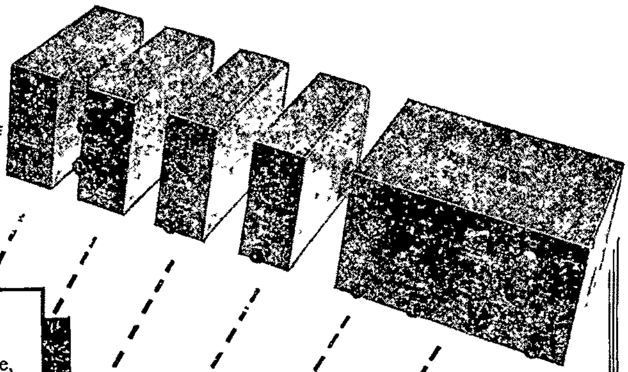
The BTL KARL FISCHER apparatus is self contained with a built-in end-point indicating circuit of high sensitivity, so that no external potentiometer is required Other features include —

- Two burettes, one for Karl Fischer Reagent and the other for methanol water solution for back titration
- Microammeter scale marked "Excess Water" and "Excess Fischer".
- Nozzles and connections to enable dry nitrogen to be passed over the contents of the reaction vessel
- Three types of reaction vessel are available (a) standard with no special filling facilities (b) with side tube for filling (c) with side tube for filling and base tube with stopcock for draining

Full details will be sent on request *Price £65 ex works* *Immediate delivery*

BTL SCIEX

BAIRD & TATLOCK
(LONDON) LTD
Scientific Instrument Makers
FRESHWATER ROAD, CHADWELL HEATH, ESSEX



TYPE 101A ADD-ON COUNTER

Developed for industrial and research use, the Add-on range of counting equipment comprises a number of different units which are fitted together as required to provide versatile yet inexpensive devices for the solution of a variety of counting problems

For normal counting purposes the Power Unit which incorporates the Input Decade is supplemented by as many decade "units" as the particular application requires Auxiliary units enable the equipment to be used for batch counting, or for process timing

The count is clearly displayed on ERICSSON long life cold cathode dekatron tubes

The units are rigidly assembled in line, with electrical connection between units maintained through 12 pin plugs and sockets

Available, either frame-mounted for standard rack (19″-48 3 cm) or with end plates for bench mounting

ABRIDGED SPECIFICATION

Max counting speed 3,500 per sec

Input Sensitivity 5V RMS (sine)
5V Peak (pulse)

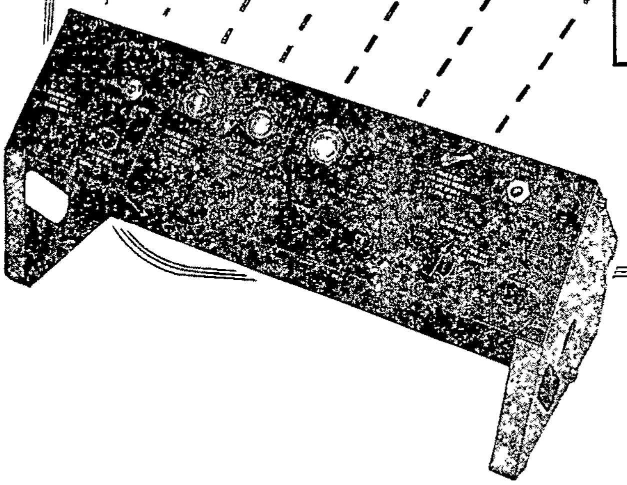
Output pulse obtainable from each decade

Internally derived 100 pulses/second for timing

Manual or electronic control of start, stop and reset

Supplies available for input probe, etc

Finish, green panel, hammer-green case



ELECTRONIC TEL NUCLEONIC
INSTRUMENTS

ERICSSON TELEPHONES LTD

HEAD OFFICE 22 LINCOLN'S INN FIELDS, LONDON, W C 2 TELEPHONE HOL 6936
WORKS - BEESTON, NOTTINGHAM, ENGLAND

Convenient Suppliers of some 3500 Eastman Organic Chemicals

Eastman's staff of skilled organic chemists, extensive production facilities, and rigid quality control have for a generation served the world's laboratories with high-quality organic chemicals

For research, for analysis, and for industrial requirements, there are now some 3500 different compounds that can be obtained through local distributors in most countries These firms will be glad to furnish you with full information and assist with your orders

EASTMAN ORGANIC CHEMICALS DISTRIBUTORS

AUSTRALIA
H B Selby & Co Pty Ltd
254A George Street
Sydney, N S W

H B Selby & Co Pty Ltd
393 Swanston Street
P O Box 409G
Melbourne, C 1

AUSTRIA
Heilmittelwerke Wien G m b H
III/40, Rennweg 12
Vienna

W J Rohrbecks Nachf
Wehrgasse 18
Vienna V

BELGIUM
Analis, S A
14, Rue Dewez
Namur

DENMARK
H Struers Chemiske Laboratorium
38, Skindergade
Copenhagen K

FINLAND
G W Berg & Co
Fabiansgatan 14
Helsinki

Havulinna Oy
P O Box 468
Helsinki

FRANCE
Touzart & Matignon
3, Rue Amyot
Paris Ve

GREAT BRITAIN
Kodak Limited
Kirkby
Liverpool

GREECE
"Michael Ant Peracakis"
2, Gladstonos Str
Athens

HOLLAND
N V Holland Indonesia Agenturen Mij
HIAM
139 De Ruyterkade
Amsterdam C

INDIA
The Andhra Scientific Co , Ltd
4, Blacker's Road, Mount Road
Madras

Raj-Der-Kar & Co
Commissariat Building
Hornby Road, Fort
Bombay

INDONESIA
N V Chemicalienhandel
Rathkamp and Co
18 Djalan Madja Pahit
Djakarta

ITALY
Lepetit S p A
Via Carlo Tenca, 34
Milan

NEW ZEALAND
Kempthorne, Prosser and Co's
New Zealand Drug Company, Ltd
P O Box 1495
Wellington, C 1

Kempthorne, Prosser and Co's
New Zealand Drug Co , Ltd
P O Box 319
Dunedin, C 1

NORWAY
Nerliens Kemisk-Tekniske Aktieselskap
Tollbodgt 32
Oslo

PAKISTAN
Aznic Scientific Works
Nicholson Road
Lahore

PORTUGAL
Sampaio Baptista & Santos, Lda
Rua dos Correeiros, 113-3°
Lisbon

SOUTH AFRICA
Kodak (South Africa) Limited
"Kodak House"
C/o Shortmarket and Loop Streets,
Cape Town

SPAIN
Establecimientos Jodra
Apartado 435
Madrid

Casimiro Busquets
Paseo de Gracia, 11, 4°, 4a
Barcelona

SWEDEN
Rudolph Grave A/B
Box 3082
Stockholm 3

SWITZERLAND
Dr Bender & Dr Hobein AG
Riedtlistrasse 15a
Zurich 6

Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N Y, U S A

DPi

There are some 3500
regularly supplied Eastman Organic Chemicals
for science and industry

Distillation Products Industries *is a division of* **Eastman Kodak Company**

For scientific electronics...

In its most advanced form, specialised production in electronics today calls for the combined skill, knowledge and experience of a diversity of scientists and technicians and may employ a similar diversity of resources at the stage of physical interpretation, if the sum of this intelligence is to result in the most efficient end product.

Plessey number all these facilities, and many others, as closely integrated parts of a single division — the Electronics Division — and are, in consequence, able to offer a rare if not unique service to manufacturers for the limited or quantity production of their products.

Among those renowned organisations which have current contracts with Plessey are included BTH, Decca, IAL, Kelvin Hughes, Marconi's Wireless Telegraph Company Ltd., and Laurence Scott & Electromotors Ltd.

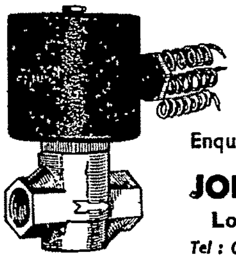
... quantity or specialised production by

Plessey

ELECTRONICS DIVISION
TELEPHONE VALENTINE 8855
THE PLESSEY COMPANY LIMITED
ILFORD ESSEX

PES

Concordia Valves



SOLENOID VALVES
Temperature and Pressure
CONTROLS
Enquiries for special applications Invited
JONES & STEVENS LTD.
Long Lane, Littlemore, Oxford
Tel: Oxford 77912 Cables Instruments, Oxford

Official repairing agents in Great Britain for Carl Zeiss of Jena and Bausch & Lamb, U S A

REPAIRS to ANY MAKE of
MICROSCOPE : MICROTOME
MICROPHOTOGRAPHIC APPARATUS
METALLOGRAPHIC APPARATUS, ETC.
Special apparatus made to customers' designs or instructions

B. COOK & S. PERKINS
Pembroke Works, Pembroke Rd., Muswell Hill, London, N.10 *Telephone* TUDor 9731-2-3

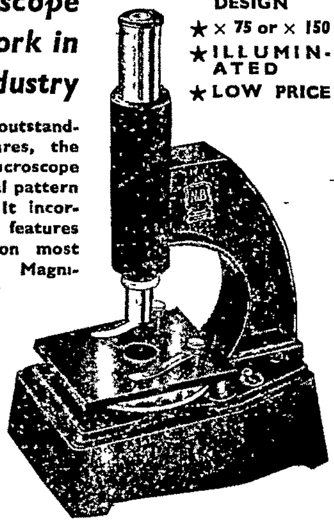
The **CHADWICK**

The ideal microscope for low power work in education and industry

★ ADVANCED DESIGN
★ × 75 or × 150
★ ILLUMINATED
★ LOW PRICE

Besides embodying several outstanding and interesting features, the CHADWICK illuminated microscope departs from the traditional pattern by its advanced design It incorporates new illuminating features which will be standard on most microscopes in the future Magnification × 75 or × 150 Other optical equipment available for different magnifications Literature gladly sent on request.

PRICE
£12 12s. 0d.



NEWBOLD & BULFORD LTD
ESTABLISHED 1794
Manufacturers and Exporters of Optical and Scientific Instruments and Ophthalmic Supplies &c
ENBEECO HOUSE, ROGER ST., GRAYS INN RD., W.C.1.
TELEPHONE: CHANCERY 5614 (3 LINES) · TELEGRAMS: BULFORD, PHONE, LONDON

"Enbeeco" PRODUCTS
DISTRIBUTORS
LEECH
PRODUCTS

Microscope Bargains

Secondhand Bargains Beck Laboratory, £48 10s, Zeiss, 3 eyepieces, 3 objectives, £33 10s, Watson "Service," 2 objectives, £28 10s, Spencer, Laboratory, 3 objectives, £42 10s, C T & S Medical, 2 objectives, £22 10s, Watson "Kima," 2 objectives, £22 10s, Baker, Laboratory, £52 10s, Beck 47C (2a), £45 10s, Swift, Botanical, 2 objectives, £8 10s, Beck Medical, 3 objectives, £32 10s

BY APPOINTMENT TO
H.M. QUEEN ELIZABETH THE QUEEN MOTHER —— THE LATE KING GEORGE VI ——
SUPPLIERS OF PHOTOGRAPHIC EQUIPMENT

WALLACE HEATON LTD

127 NEW BOND STREET, LONDON, W 1 MAYFAIR 7511

TRADE **JAYGO** MARK

Special & Standard Scientific Apparatus & Glassware

GLASS EQUIPMENT FOR FUME ABSORPTION

LABORATORY HOSPITALS AND PILOT PLANT EQUIPMENT FOR ANALYTICAL EDUCATIONAL AND RESEARCH PURPOSES

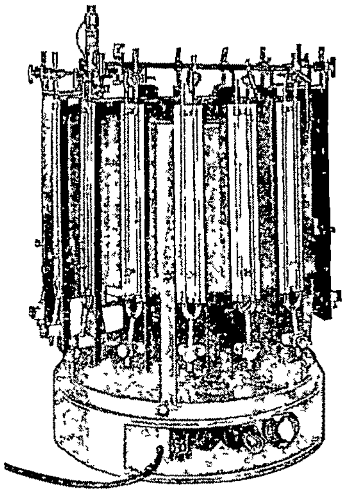
THE JAGO COMPANY

90 RUSHOLME ROAD, MANCHESTER, 13

HOSLAB
Regd Trade Mark
Laboratory Equipment

WARBURG CONSTANT VOLUME RESPIROMETER

(LEAFLET ON APPLICATION)



CIRCULAR BENCH MODEL
RECTANGULAR MODEL ALSO AVAILABLE

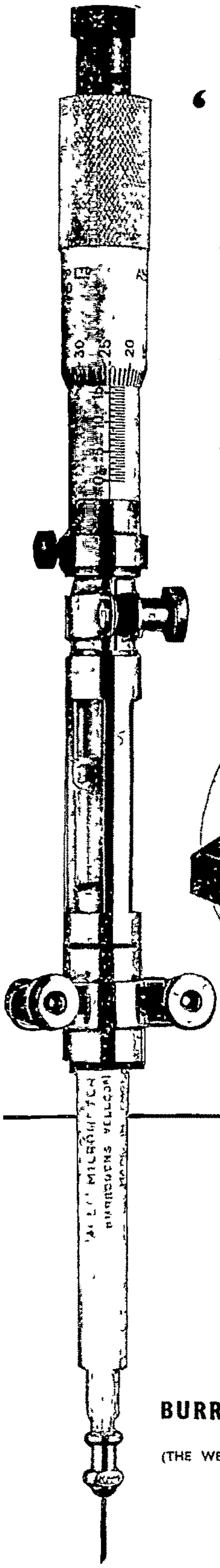
HOSPITAL AND LABORATORY SUPPLIES LTD.

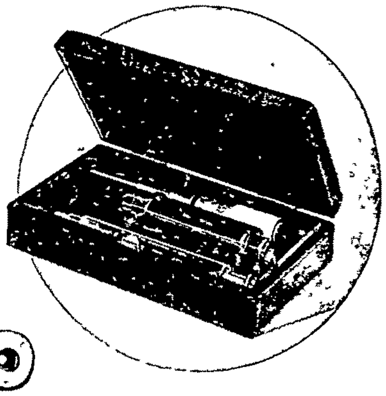
12 CHARTERHOUSE SQUARE, LONDON, E.C 1
COMPLETE LABORATORY FURNISHERS

'AGLA' BRAND

MICROMETER SYRINGE

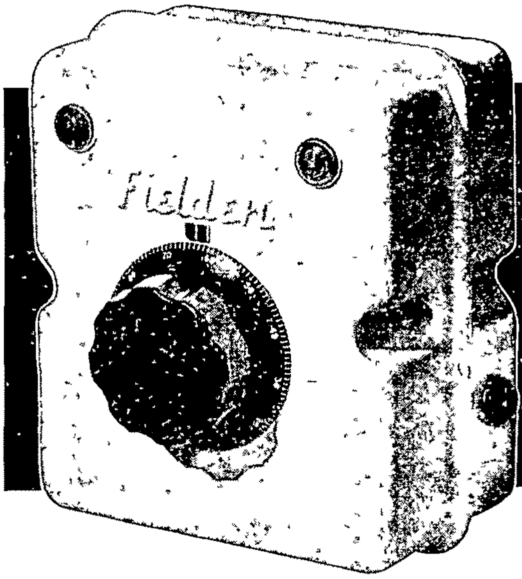
A precision instrument capable of measuring volumes of fluid as small as 0·01 mil. with an accuracy of ± 0 00005 mil.





BURROUGHS WELLCOME & CO.
(THE WELLCOME FOUNDATION LTD) **LONDON**

AN ELECTRONIC PRECISION THERMOSTAT BY Fielden INSTRUMENTATION



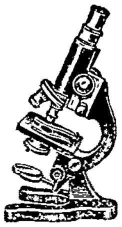
1. **RAPID RESPONSE** Two seconds for temperatures below 250°C. Up to 7 seconds for maximum temperature of 500°C.
2. **LONG TERM ACCURACY** Operates on 0.1°C temperature change with first-class reproducibility. Long-life resistance thermometer bulbs, interchangeable without re-calibration.
3. **EASY SETTING** Control setting by clearly-read dial.
4. **SIMPLE, ROBUST, TROUBLE-FREE** Stainless-steel bulb sheaths, robust relay contacts, dustproof housing.
5. **REASONABLE COST** Simple design makes for low initial cost.

This instrument is designed for use in applications necessitating very accurate temperature control and for such normal purposes as oven and waterbath control It provides warning of deviation from the pre-set temperature and/or on/off electrical control Good delivery can be offered Please ask for leaflet 219FE for ranges available, etc Other temperature instruments, recorders, controllers, etc, are described in publication 209FE

Fielden INSTRUMENTATION

FIELDEN ELECTRONICS LTD • WYTHENSHAWE • MANCHESTER
Telephone. WYThenshawe 3251 (4 lines). *Telegrams HUMIDITY, MANCHESTER*
London Office : 21 Buckingham St., W.C.2. Telephone : TRAfalgar 3154

MICROSCOPES
and
ACCESSORIES



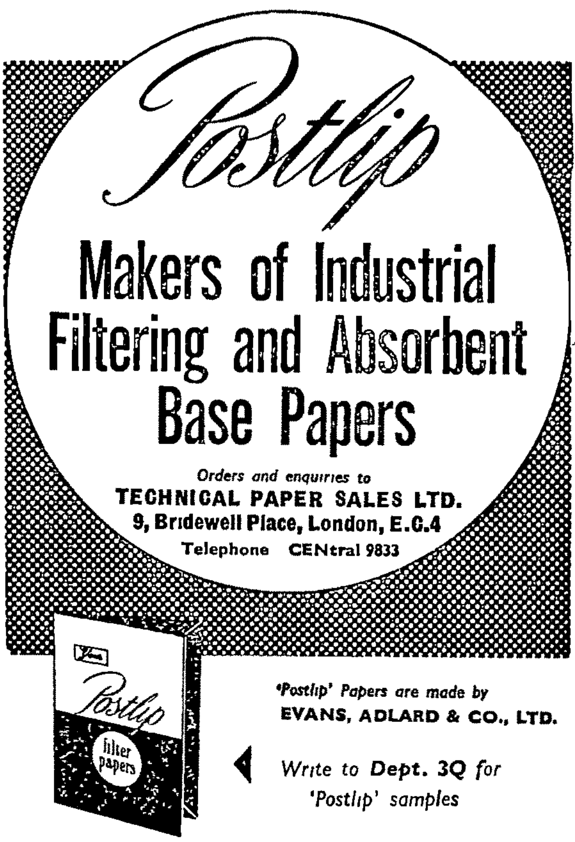
●

Our experience is always available to assist in the selection of suitable microscopes.
We are agents for all the leading makers

We also supply
Stains and Reagents for Microscopy
General Laboratory Equipment
Glass and Porcelain Ware

Experts in Microprojection
Catalogues on Application

FLATTERS & GARNETT LTD.
Microscopists & Scientific Instrument Makers
309 Oxford Road, Manchester 13
Over 50 years' Service to Microscopy Est 1901



Makers of Industrial Filtering and Absorbent Base Papers

Orders and enquiries to
TECHNICAL PAPER SALES LTD.
9, Bridewell Place, London, E.C.4
Telephone CENtral 9833

'Postlip' Papers are made by
EVANS, ADLARD & CO., LTD.

Write to **Dept. 3Q** *for 'Postlip' samples*

MODERN LABORATORIES

. . . individually planned and designed for their particular purposes Over half a century of widespread experience of different types of Laboratories enables us to offer suggestions and designs based on the best of present-day developments

Our Technical Department is always available for free consultation and advice

Some Laboratories recently equipped by us:
Production . . . . J. Lyons & Co. Ltd.
Routine . . . . Express Dairy Co. Ltd.
Research, Routine, etc. . . . Glaxo Laboratories Ltd.
Chemical . . . . University College, London

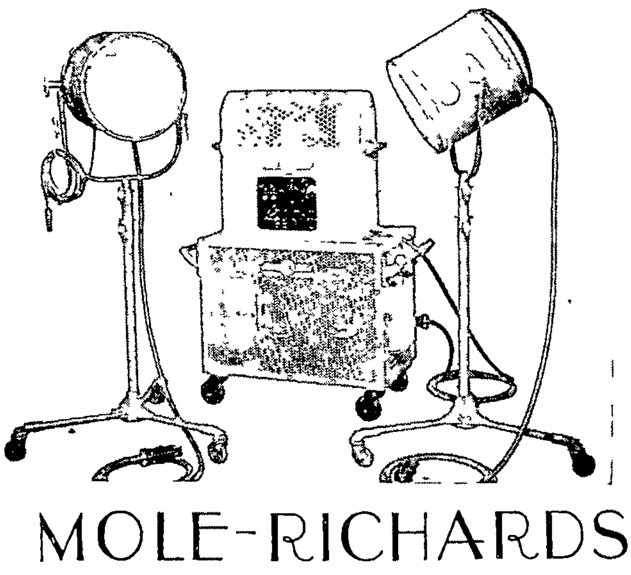
With acknowledgments to Glaxo Laboratories Ltd.

CHARLES HEARSON & COMPANY LIMITED

68 WILLOW WALK, BERMONDSEY, LONDON, S.E.1. (BER, 4494—4 lines)

Lighting for High-speed Cinematography

For the illumination of small areas for brief periods at extremely high brightness levels, the CINE-FLASH provides accuracy of control and repeatability of results, and produces the minimum of heating



CINE MOLE-RICHARDSON (ENGLAND) LTD FLASH

SPECIFICATION

LIGHT SOURCE Mazda mercury-cadmium discharge lamp, continuously rated at 1 KW, with special electrodes permitting it to be flashed at very high power for short periods

LAMP FITTING Parabolic reflector, 13 in dia, with alternative diffusing glasses giving either a narrow or wide angle beam.

CONTROL UNIT Designed to operate one or two lamps, each at
3 KW for 5 seconds,
5 KW for 2 seconds, or
10 KW for 1 second

The circuit includes also high-voltage impulse ignition system, and provision for remote control

RECTIFIER For operation on A C, a 3-phase mercury rectifier is provided

ILLUMINATION DATA The following intensities are typical of the results attained by each lamp at the 10 KW loading (at other settings the illumination is proportional to the wattage)

	Distance (ft)	Illumination at centre of spot, foot-candles	Dia of spot to 70% of maximum intensity (in)
With normal diffusing glass	4	150,000	10
	10	30,800	15
	30	2,700	32
With wide divergence glass	4	16,500	33
	10	3,370	50
	30	300	106

MOLE-RICHARDSON (ENGLAND) LTD.

Chase Road,
London, N W.10

Telephones . ELGar 6834 (5 lines)
Cables Molereng, London

Fine Quality 17-Jewel

CHRONOGRAPH

Stainless Steel Case

Model W.C 2.

Beryllium alloy, non-magnetic overcoil balance spring, temperature variation producing negligible effects Safety device to eliminate effects of shock on balance spring The balance assembly is supported between shock-proof bearings The entire movement embodies the latest technical improvements **£30 5s. 0d.** Also available as Model W C 2a in stainless steel moisture-proof case **£34 0s. 0d.** *Further particulars of these and other first-quality watches, chronographs and stop watches, are given in our new catalogues, copies of which will be gladly sent on request.*

Guaranteed repairs Timing service Certification

CAMERER CUSS

Timing Division

Makers of Good Clocks & Watches since 1788

AT

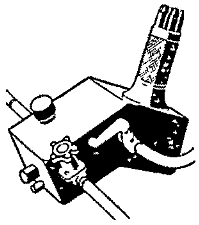
NEW OXFORD STREET, LONDON, W.C.1

MUSeum 8968/9

Our only other address 91 Kingsway, W C 2

Add this skilled worker to your laboratory staff . . .

If you manipulate glass, you need the Scorah Oxy-Coal-Gas Blowpipe—the Blowpipe that gives the right size flame by a simple turn of the turret It is the most efficient Blowpipe ever produced, and once installed in the laboratory will be in constant use It will render instant valuable service in making that new idea or gadget, modifying existing apparatus or repairing the little casualties Your staff will have the opportunity to develop skill in handling 'Pyrex,' 'Phoenix' or 'Hysil' with a tool specially designed to change glass-blowing from a frustration into a fascination For the more expert it provides much greater speed on the job, plus certainty and mastery via smoothly burning, quiet, stable flames of just the right size for the work in hand.



Price

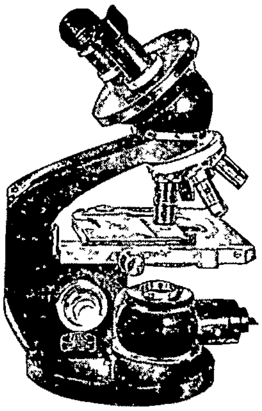
£19. 10. 0.

Send for descriptive leaflet

L.V.D. SCORAH M.Sc. 44, NORTHFIELD RD. BIRMINGHAM, 30.
phone: KINGS NORTON 1885

CARL ZEISS

W MODEL MICROSCOPE



The pre-eminent instrument Integral illumination Pre-centred condensers Immediate change from bright field to phase contrast Optovar magnification changer

DEGENHARDT & CO., LTD.

32 MADDOX STREET, LONDON, W 1

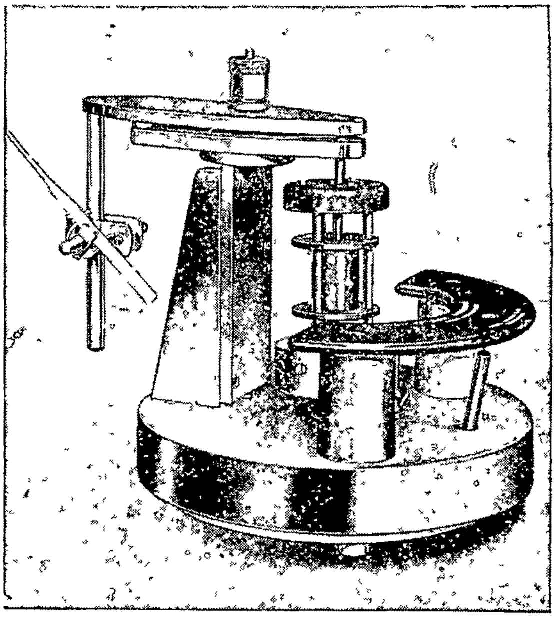
Mayfair 6639

Sole Importers for Gt Britain and N Ireland

SINGER MICROMANIPULATORS

(patent application 11559/43 Foreign patents pending)

As described by Barer and Saunders-Singer, Q J M S., Vol. 89, pp 439-74, Dec 1948



SINGER INSTRUMENT COMPANY LIMITED

Fountain Court, 83 London Street, Reading, Berks, England

Manufacturers also of the Singer Microdissectors

Manufacturers of optical elements for laboratories and instrument makers

*

M. Bender (Northern) Ltd.

Optical Works—
5-21, High Friar Street,
Newcastle upon Tyne, 1
Tel 2-4005/6

Glass Tubing with precision bore...

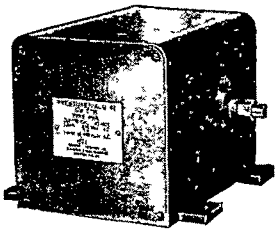
Chance Veridia (regd) precision bore glass tubing is made with bore diameters ranging from 0·04mm to 34·5mm The variation from the nominal bore diameter does not exceed ±0·01mm (0·0004") Veridia tubing is made from heat resisting glass of low thermal expansion (A leaflet giving details of standard sizes and lengths is available on request)

Chance VERIDIA glass Tubing

CHANCE BROTHERS LTD , Smethwick 40, Birmingham
London Office 28 St James's Square S W 1

SENSITIVE

PRESSURE SWITCH



TYPE PV/LI

The Type PV/LI pressure/suction switch operates in the range from ½ in. to 10 in. w g , and may be used with non-corrosive gases or liquids in ambient temperatures up to 120° C The instrument uses a large bellows as the pressure sensitive unit, which is coupled through suitable linkages to a heavy duty mercury switch

A catalogue describing the switch shown above and other models is available on request

DELTA TECHNICAL SERVICES LTD
FAIRFIELD ROAD . KINGSTON-ON-THAMES . SURREY
TEL. KINgston 9568-9

GLASS

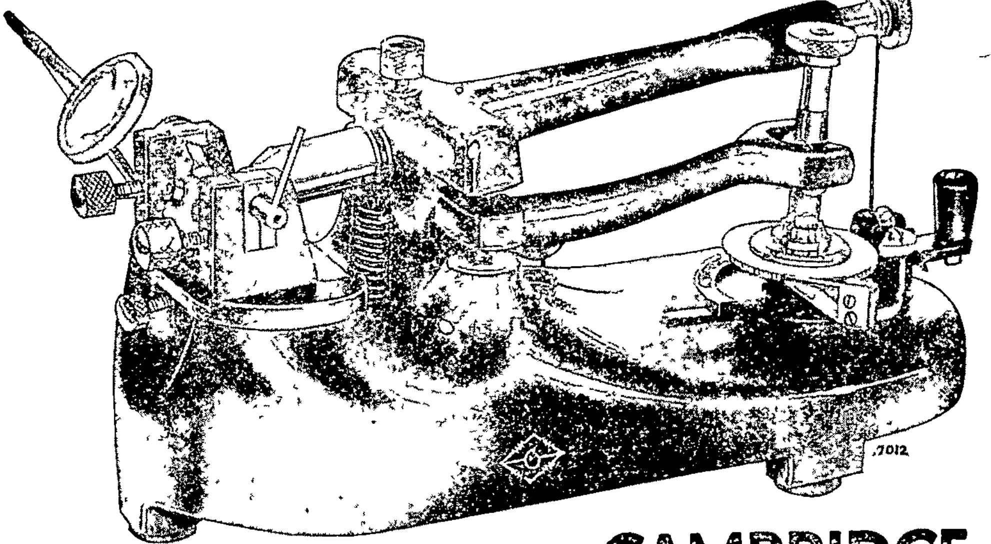
All Glass Requirements for Scientific Instrument Manufacturers and Research Workers

- SHEET & PLATE-GLASS—cut and ground to exact dimensions
- LENSES, PRISMS & FLATS—to any standard of accuracy
- MIRRORS—back silvered and front surface aluminised, etc
- BLOOMING of optical components

C. J. WHILEMS, LTD.
ILFORD OPTICAL WORKS
FOREST ROAD, BARKINGSIDE, ESSEX

Telephone : HAInault 5454-5

NEW CAMBRIDGE MICROTOME



Similar to the Cambridge "Rocker," but for cutting sections down to 0 0001 mm *thin*. Specially suitable for high-power microscopy.

Details in our new
SHEET No. 293-N
May we send a copy?

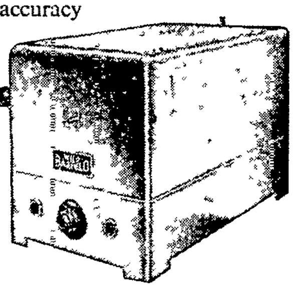
CAMBRIDGE
INSTRUMENT CO. LTD.
13 GROSVENOR PLACE, LONDON, S.W.1
WORKS LONDON & CAMBRIDGE

Ask also for details of the new ULTRA-FINE SECTION MICROTOME cutting sections 0 000025 mm., for use with the ELECTRON MICROSCOPE

Horizontal Rectangular MUFFLES

Wild-Barfield, the largest manufacturers of laboratory muffles, produce four standard models which will meet most requirements

Precise temperature control is possible with these muffles, thus allowing laboratory processes to be undertaken with great accuracy



Operating temperature up to 1000°C The chamber sizes are from 8″ × 3″ × 3″ to 19″ × 7½″ × 5″

Single or twin tube and high temperature muffles are also available Full details will gladly be supplied

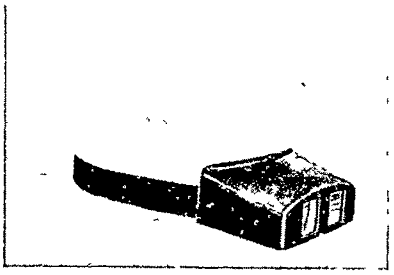
WILD-BARFIELD

ELECTRIC FURNACES
for all *heat-treatment purposes*

Wild-Barfield Electric Furnaces Ltd,
23 Elecfurn Works, Watford By-Pass, Watford, Herts
Telephone Watford 6091

ELECTRIC WILD BARFIELD FURNACES

MAGNIFIERS



The headband magnifier which is illustrated is one of the 200 different types described in our free booklet, "Magnifiers and Visual Aids" Hand reading glasses, watchmakers' eyeglasses, triple achromatic loupes, illuminated stand magnifiers, telescopic spectacles all are included

Please ask us to send a copy.

RAYNER
100 NEW BOND STREET, LONDON, W 1
Telephone GRO 5081

in the figure were determined by inspection of the time-record of the temperature gradient

When heating is applied at the initial state of zero gradient, the adverse temperature gradient builds up gradually and follows characteristic trends in the conductive and convective regions of heat transfer respectively In the conductive region, the temperature gradient reaches a certain limiting value and remains at that value for continuous heating In the convective region, the temperature gradient reaches a peak value, then breaks into oscillation around a slightly lower value.

In both regions of heat transfer, empirical linear relations between the heating-rate and the temperature gradient were obtained by various experimenters[5,6,8]. Therefore, the transitional region was defined by the obvious deviation from the linear relationship, and the record of non-oscillatory breakdown

Since the intensity of the magnetic field varied considerably within the region occupied by the container from 1,250 gauss near the outer radius of cylinder to 1,750 gauss at the top and the bottom, this transitional region most probably is due to the earlier onset of convection in weaker parts of the field

The results of the experiment, in terms of the critical Rayleigh numbers, are shown in Table 1 for four different depths of the mercury layer, where the values of critical temperature gradient for the non-magnetic case were evaluated from the value of the critical Rayleigh number of 1,708 It may be noted that the boundary conditions that actually obtained are those for two rigid surfaces, because of the presence of a contaminant film on the top surface of the mercury

Table 1

Depth (cm)	For $\frac{Q}{H}$ = 1,500 gauss	Critical Rayleigh number obtained	Measured critical gradient temperature (deg C /cm)	Critical temperature gradient for non-magnetic case (deg C /cm)
3 0	$1\ 2\times10^4$	$1\ 38\times10^5$	0 478	$5\ 92\ \times10^{-3}$
4 0	$2\ 2\times10^4$	$2\ 49\times10^5$	0 273	$1\ 88\ \times10^{-3}$
5 0	$3\ 4\times10^4$	$3\ 82\times10^5$	0 171	$0\ 768\times10^{-3}$
6 0	$4\ 9\times10^4$	$5\ 42\times10^5$	0 117	$0\ 371\times10^{-3}$

These values of the critical Rayleigh number practically coincide with the theoretical values given by Chandrasekhar as seen in Fig 2, where the estimated average intensity of the magnetic field of 1,500 gauss is used for Q It is particularly striking that, in spite of the difficulties associated with the non-uniformity of the magnetic field, the theoretical slope is closely approximated by the four points in Fig. 2 Thus the experiment verifies the predicted inhibition effect on the onset of convection in an electrically conductive liquid under an external magnetic field

The details of this work will be published elsewhere. The encouragement and guidance given by Prof. S. Chandrasekhar and Dr D Fultz are acknowledged, thanks are also due to Prof M Schein and Dr C. M. York for the use of the magnet. The investigation has been made possible through support and sponsorship extended by the Geophysics Research Division, Air Force Cambridge Research Center, under a contract.

[Dec 18

[1] Benárd, H , *Rev Gen Sci Pur App* , **12**, 1261, 1309 (1900) , *Ann Chem and Phys* , **23**, 62 (1901)

[2] Rayleigh, Lord, *Phil Mag* , (6), **32**, 529 (1916)

[3] Jeffreys, H , *Phil Mag* , (7), **2**, 833 (1926) , *Proc Roy Soc* , A, **118**, 195 (1928) , *Proc Camb Phil Soc* **26**, 170 (1930)

[4] Pellew, A , and Southwell, R V , *Proc Roy Soc* , A, **176**, 312 (1940)

[5] Schmidt, R J , and Milverton, S W , *Proc Roy Soc* , A, **152**, 586 (1936)

[6] Malkus, W V R , *Proc Roy Soc* (in the press)

[7] Chandrasekhar, S , *Phil Mag* , (7), **43**, 501 (1952) , **45**, 1177 (1954).

[8] Frenzen, P , and Nakagawa, Y , *Tellus* (in the press)

STRUCTURE OF THE ISOMERIC 2:4-DINITROPHENYLHYDRAZONES OF SOME ALPHA-KETO-ACIDS IN RELATION TO THEIR INFRA-RED SPECTRA

By Dr F. A ISHERWOOD

Low Temperature Station for Research in Biochemistry and Biophysics, University of Cambridge, and Department of Scientific and Industrial Research

AND

R LUMLEY JONES

Edward Davies Chemical Laboratories, University College of Wales, Aberystwyth

THE discovery that each α-keto-acid could give two 2 4-dinitrophenylhydrazones has already been described in connexion with the separation and analysis of mixtures of pyruvic, oxalacetic and α-keto-glutaric acids on paper chromatograms[1]. The two hydrazones obtained from each α-keto-acid were provisionally regarded as stereoisomers about the —C=N— linkage, though it was not possible definitely to identify the individual isomers as *cis* or *trans*. The R_F values did not bear any simple relationship to each other, such as might have been expected by analogy with the separation of diastereoisomeric sterols on alumina[2] In fact, they varied so widely with the α-keto-acid and the nature of the chromatographic system that the presence of steric factors other than *cis-trans* isomerism was suggested.

The present study was undertaken in order to provide confirmatory data for the structural assignment of the hydrazones as geometrical isomers and to elucidate the nature of the steric factors which affect the chromatographic properties of the isomers. For this purpose 20–30 mgm. of the isomeric hydrazones were separated on paper chromatograms, using paper which had been buffered to pH 8 0 (for conditions see ref 1) The separated hydrazones were extracted with 0 2 M sodium bicarbonate, and under these slightly alkaline conditions were quite stable. To prepare the free hydrazones, the sodium bicarbonate extract was acidified to pH 2 0 with dilute sulphuric acid and extracted with chloroform containing 10 per cent ether The chloroform extract was dried over anhydrous sodium sulphate and then

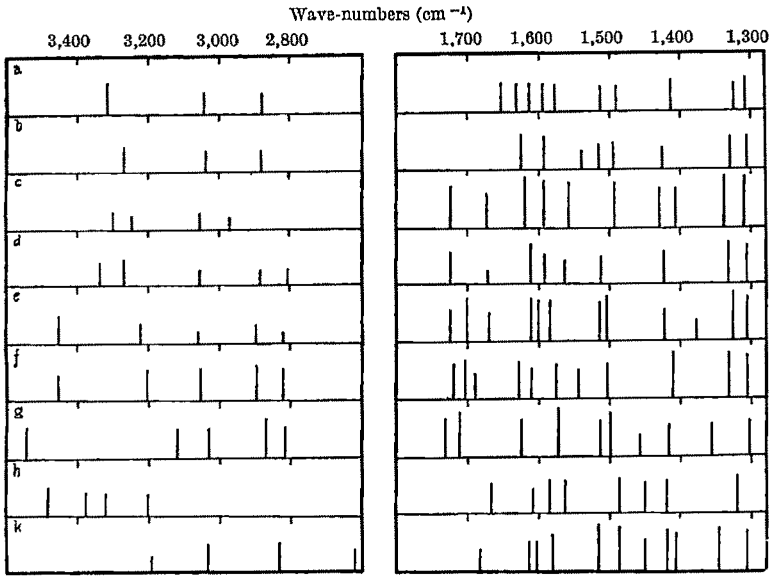


Fig 1 Infra-red absorption spectra of
(*a*) 2 4-Dinitrophenylhydrazine
(*b*) Acetaldehyde 2 4-dinitrophenylhydrazone
(*c*) Pyruvic acid 2 4-dinitrophenylhydrazone (1)
(*d*) Pyruvic acid 2 4-dinitrophenylhydrazone (2)
(*e*) α-Keto-glutaric acid 2 4-dinitrophenylhydrazone (1)
(*f*) α-Keto-glutaric acid 2 4-dinitrophenylhydrazone (2)
(*g*) Oxalacetic acid 2 4-dinitrophenylhydrazone
(*h*) Anthranilic acid
(*k*) N-2 4-Dinitrophenylanthranilic acid

evaporated to dryness *in vacuo* The hydrazones were prepared as rapidly as possible, and at no time were they subjected to temperatures above 15–20° Examination of their infra-red spectra was complete within twenty-four hours of preparation Even so, the isomeric hydrazones of oxalacetic acid had become inter-converted sufficiently for the spectra to be indistinguishable. In the case of pyruvic acid, the change was sufficiently slow not to interfere with the interpretation of the results (equilibrium was not reached even after three to four weeks at room temperature). The hydrazones of α-keto-glutaric acid were stable

The infra-red spectra were all obtained with the substances in the solid state and ground with a suitable quantity of liquid paraffin to form a mull. Where absorption of the paraffin was too strong for the detection of bands due to the compounds being studied, hexachlorbutadiene was used instead[3]. The instrument used was a single-beam infra-red spectrometer fitted with a rock-salt prism It was very carefully sealed, mainly by means of high-vacuum wax, until the flow of a litre or so of nitrogen through the apparatus from a cylinder of compressed gas was enough to reduce the water-vapour content to a few per cent of the original.

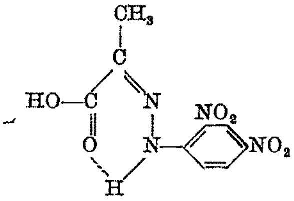
The infra-red spectra were naturally of some complexity. The details of each compound, anthranilic acid, N-2 4-dinitrophenylanthranilic acid, 2 . 4-dinitrophenylhydrazine and the 2 4-dinitrophenylhydrazones of acetaldehyde, pyruvic acid (1 and 2), α-keto-glutaric acid (1 and 2) and oxalacetic acid (mainly 2) are given semi-diagrammatically in Fig. 1. The height of the vertical lines, which represent absorption bands, is a measure of the intensity of the bands (per cent absorption). The only drawback to this method of presentation is that shoulders on the sides of main absorption bands appear as distinct peaks. However, where this has occurred and it has any bearing on the interpretation of the results, the fact has been indicated in the text

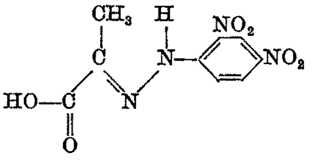
A brief inspection of the structure of the compounds, assuming them to be geometrical isomers, suggested that interaction might be possible between the carbonyl of the carboxylic acid group and the imino group attached to the aromatic ring Such interaction might well affect the absorption bands of both the carbonyl group and the imino group In the present study, attention was focused more particularly on the nature of the absorption arising from the stretching of the carbonyl link, because the bands attributable to this cause are characteristic and occur in a part of the spectrum which is free from interference due to the 2 4-dinitrophenylhydrazine residue (compare with the spectra of the free hydrazine and acetaldehyde hydrazone). An additional advantage is that the position of the carbonyl frequency is not appreciably modified by differences in crystalline form The positions of the absorption bands arising from the stretching of the imino link were obscured by uncertainties in the calibration of the instrument and the relatively poor resolution obtained with the rock-salt prism in this part of the spectrum The spectrum of each compound will be discussed in turn

Pyruvic acid 2 *4-dinitrophenylhydrazone* (1), R_F 0 6 on paper buffered to *p*H 8 0 (cf ref. 1), melting point 208° (decomp), λ_{max} 380 mμ in 0 2 *M* sodium bicarbonate, gives very little red colour with 1–1 5 *N* sodium hydroxide (0 001 *M*)

The compound gives rise to two absorption bands, at 1,722 and 1,672 cm $^{-1}$ That both these bands are associated with the carbonyl linkage is borne out by the fact that they disappear in the spectrum of the sodium salt The presence of a subsidiary band at 1,672 cm.$^{-1}$ suggests that some form of chelation has taken place in a substantial proportion of the absorbing molecules Whereas normal saturated aliphatic acids absorb strongly in the region 1,725–1,700 cm.$^{-1}$ in the solid state, it has been shown by Flett[4] that, in a significant number of cases where chelation can occur between the carbonyl linkage and an amino or imino hydrogen, absorptions occur below 1,680 cm $^{-1}$.

In order to supply confirmatory evidence, the spectra of anthranilic acid and its N-2 4-dinitrophenyl derivative were obtained. These molecules give rise to single absorptions at 1,667 and 1,679 cm $^{-1}$ respectively, from which it may be deduced that chelation is complete This would be facilitated by the proximity of the carboxyl and amino (or imino) groups The actual positions of the bands may not be strictly comparable, due to the possibility of conjugation between the carbonyl linkage and the benzene ring Taking the structure normally assigned to the hydrazones of α-keto-acids, the most likely explanation of the occurrence of the band at 1,672 cm $^{-1}$ in the present isomer is that hydrogen bonding occurs between the hydrogen of the imino group


(I)


(II)

of the 2 · 4-dinitrophenylhydrazine residue and the carbonyl oxygen of the carboxyl group (see I).

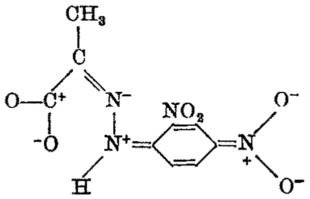
Pyruvic acid 2 4-dinitrophenylhydrazone (2), R_F 0·4, melting point 210° (decomp.), λ_{max} 370 mμ in 0·2 *M* sodium bicarbonate, gives a characteristic red colour with 1–1·5 *N* sodium hydroxide (0·001 *M*)

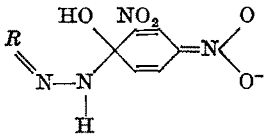
The spectrum in the carbonyl region is characterized by the appearance of a strong absorption band at 1,726 cm.$^{-1}$ together with a very weak absorption at 1,676 cm.$^{-1}$. It is highly probable that this absorption arises from contamination with a trace of the other isomer. The absence of a band of any appreciable intensity below 1,680 cm.$^{-1}$ precludes the possibility of any form of chelation in the molecule, and the value (1,726 cm.$^{-1}$) of the carbonyl frequency eliminates the possibility of ring formation with the resulting modification of the carbonyl group. The structure would be represented by (II)

These structures (I and II) are consistent with the other properties of the compounds The melting point of (I) is slightly lower than (II), though this is scarcely significant because melting points accompanied by decomposition are not very characteristic and in addition there is a marked inter-conversion of such isomers at the melting point[5]. The sodium salts of (I) and (II) will have the same configuration, but without the hydrogen bond between the imino group and the carbonyl group The higher R_F value of the sodium salt of (I) on paper chromatograms is a reflexion of the steric interference of the neighbouring phenyl group on the ability of the ionized carboxyl to attract water molecules and become incorporated in the water–cellulose complex[6]. Such steric factors are not present in (II) The higher λ_{max} of (I) in the ultra-violet as compared with (II) is probably due to the stabilization of an excited state such as (III), as a result of electrostatic attraction (cf Ramirez and Kirby[5])

The deep red colour given by most 2 4-dinitrophenylhydrazones of ketones in alkali is probably due to the attack by an OH$^-$ to give a compound such as (IV) (or resonance form) In the case of (I) the approach of the OH$^-$ is hindered by the proximity of the ionized carboxyl group, and little or no red colour is formed. (II) gives the usual red colour.

α-Keto-glutaric acid 2 4-dinitrophenylhydrazone (1), R_F 0·28, melting point 145° (decomp), λ_{max} 387 mμ in 0·2 *M* sodium bicarbonate, gives a weak red colour with 1–1·5 *N* sodium hydroxide (0·001 *M*).


(III)


(IV)

The spectrum is characterized by the appearance of an intense absorption at 1,707 cm.$^{-1}$ which is flanked by a shoulder at 1,724 cm.$^{-1}$ and a subsidiary peak at 1,673 cm.$^{-1}$ The band at 1,707 cm.$^{-1}$ corresponds to the single band shown by the higher members of the aliphatic dicarboxylic acids series at about 1,700 cm.$^{-1}$. Oxalic and malonic acids give rise to two carbonyl absorptions, but they are anomalous. The other two absorptions, at 1,724 cm.$^{-1}$ and 1,673 cm.$^{-1}$, lie in exactly the same positions as the absorptions of isomer (I) of pyruvic acid. This would seem to indicate a similar type of structure to that postulated for the pyruvic isomer (I).

α-Keto-glutaric acid 2 4-dinitrophenylhydrazone (2), R_F 0·16, melting point 215° (decomp), λ_{max} 377 mμ in 0·2 *M* sodium bicarbonate, gives a moderately strong red colour with 1–1·5 *N* sodium hydroxide (0·001 *M*)

As in the case of the faster moving derivative, this compound gives rise to an intense band centred at 1,705 cm.$^{-1}$ The shoulder to this band at 1,717 cm.$^{-1}$ and a weaker peak at 1,682 cm.$^{-1}$ point to a lower degree of hydrogen bonding, since they are separated by 35 cm.$^{-1}$ instead of 51 cm.$^{-1}$ as in the faster moving compound. The hydrogen bond is possibly between the carbonyl of the carboxyl farthest away from the hydrazine residue and the imino hydrogen, thus suggesting that an 8-membered ring is present.

The other properties of these compounds agree with the conclusions drawn from the infra-red study As in the case of pyruvic acid, the *cis* isomer ((I) in the case of pyruvic acid) has the lower melting point, higher λ_{max} and gives a rather weaker red colour with alkali. The red colour of both isomers is weak compared with that of pyruvic acid (II), and this may be ascribed to the effect of the ionized carboxyls near the phenyl group shielding it from attack. The high R_F value of the *cis* isomer in solvents containing large amounts of ammonia may be ascribed to the fact that the free carboxyl in this case is very weak (pK_a about 6, the other has pK_a about 3), and the ammonium salt is largely undissociated and therefore more soluble in organic solvents

Oxalacetic acid 2 . 4-dinitrophenylhydrazones. These were too unstable as the free isomers for detailed examination λ_{max} of the faster moving isomer as compared with that of the slower (λ_{max} 385 and 370 mμ in 0·2 *M* sodium bicarbonate respectively) suggested by analogy with pyruvic acid that it had the *cis* configuration

We would like to thank Dr Mansel Davies for reading the manuscript and Dr T. Swain for the suggestion regarding the use of hexachlorbutadiene

The work described in this paper was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. [Oct 27

[1] Isherwood, F A , and Cruickshank, D H , *Nature*, 173, 121 (1954)
[2] Liebermann, S , Fukushima, D , and Dobriner K *J Biol Chem* , 182, 299 (1950)
[3] Ard, J A , *Anal Chem* , 25, 1743 (1953)
[4] Flett, M St C , *J Chem Soc* , 962 (1951)
[5] Ramirez, F , and Kirby, A F , *J Amer Chem Soc* , 74, 4331 (1952) , 75, 6026 (1953) , 76, 1042 (1954)
[6] Hanes, C S , and Isherwood, F A , *Nature*, 164, 1107 (1949)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications

Gas-Phase Chromatography

QUITE recently, papers have appeared describing in detail the process of gas-phase chromatography[1-3] Briefly, a sample of gas is injected into one end of a column packed, for example, with kieselguhr impregnated with a high-boiling organic compound such as dinonyl phthalate, and a current of nitrogen is fed into the column to elute the sample Owing to the fact that various compounds diffuse through the column at different rates, the components of the mixture emerge diluted with nitrogen and can be identified individually. Generally, some physical property of the issuing gas, such as thermal conductivity, is measured, and a continuous record of this property as a function of time is obtained Each component of the mixture shows up as a separate peak and, from the time taken for it to appear, identification can be made, the size of the peak provides a measure of the concentration Unfortunately, detectors depending on thermal conductivity vary widely in sensitivity for different gases, and the maximum sensitivity obtainable for many gases is not very high

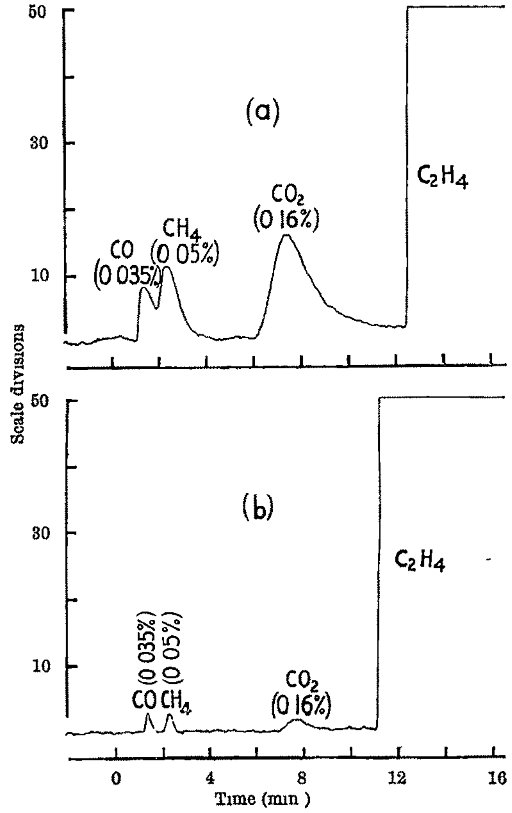


Fig 2 Chromatograms of cylinder ethylene 9 0 ml of sample. Nitrogen flow, 25 ml /min (*a*) Column temp, 20° C, at start, rising to 45° C after 3 5 min, 10-cm cell in gas analyser, sensitivity full scale for 0 06 per cent carbon dioxide (*b*) Column temp, 20° C, at start, rising to 45° C after 2 5 min, 1-cm cell in gas analyser, sensitivity full scale for 0 6 per cent carbon dioxide

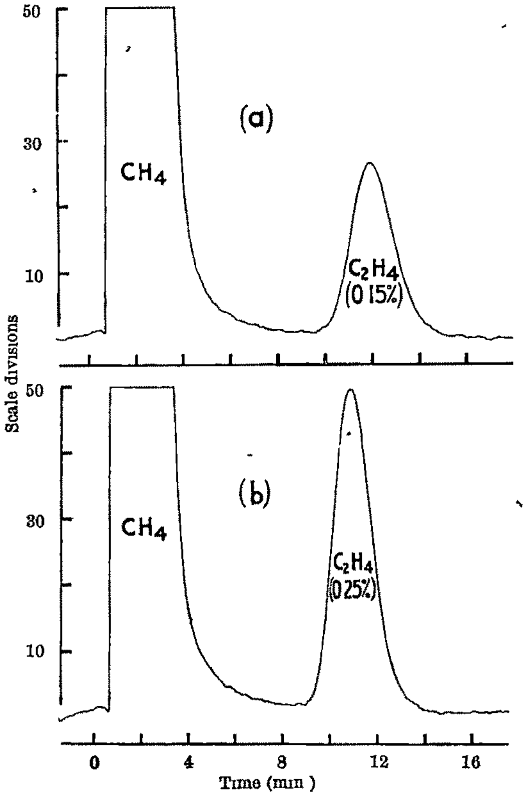


Fig 1 Chromatograms of 99 9 per cent methane 9·0 ml of sample Nitrogen flow, 30 ml /min Column temp, 57° C 10-cm cell in gas analyser, sensitivity full scale for 0 06 per cent carbon dioxide (*a*) Original sample (*b*) Sample with 0 103 per cent ethylene added

To extend the field of usefulness of gas chromatography, the need for a more uniform and more sensitive means of detecting each component as it emerges from the column has become apparent, and the infra-red gas analyser appears to meet these requirements in many cases For infra-red absorbing gases, it would suffice to use a detector in the instrument sensitive to all the compounds present in the sample, but still the sensitivity to various compounds would vary somewhat, and also adequate sensitivity might be difficult to obtain In the case of organic gases and vapours, these difficulties are readily overcome by passing each compound as it comes from the column through a tube containing copper oxide heated to dull redness, or other suitable oxidizing agents, to convert the carbon to carbon dioxide and any hydrogen to water vapour. These gases are then passed through an infra-red gas analyser provided with a detector sensitive to carbon dioxide, and as each component emerges from the column and passes into the instrument after oxidation, an indication on the output meter is obtained. This procedure (patent applied for) has the following important advantages

(1) Very high sensitivity is obtainable, since there is no difficulty in obtaining full scale for 0 01 per cent of carbon dioxide in nitrogen when using a 30-cm absorption cell.

(2) The gas from the hot copper oxide need not be specially cooled, since the rate of flow is so small that natural cooling is adequate

(3) Water formed in the combustion may condense or pass through the gas analyser as vapour. Gross amounts should be removed to avoid loss of carbon

dioxide, but the instrument is unresponsive to water vapour and careful drying is not required.

(4) Assuming that the gas analyser has been calibrated for carbon dioxide, the sensitivity to any other organic gas after combustion is simply proportional to the number of carbon atoms in the molecule.

To illustrate the power of the method, chromatograms of methane and ethylene were obtained using a column made by packing a 30-cm. length of glass tubing, 4 mm. bore, with activated charcoal[3]. The column was enclosed in a water jacket which could be heated electrically, and nitrogen was allowed to flow through the column continuously at the rate of 25–30 ml /min, a pressure head of 13 cm. mercury being required to maintain this flow. Approximately 10 ml of sample gas was injected from a gas burette, the flow of nitrogen being interrupted for a few seconds while this was done.

Fig 1 shows chromatograms of methane (said to be 99 9 per cent pure by the suppliers), with and without the addition of 0 103 per cent by volume of ethylene No impurity is disclosed in the methane except 0 15 per cent of ethylene. Fig 2(*a*) shows a chromatogram of ordinary cylinder ethylene, the presence of carbon monoxide, methane and carbon dioxide are clearly indicated Fig. 2(*b*) was obtained under similar conditions except that the path-length of the sample cell in the gas analyser was reduced from 10 cm. to 1 cm. This has the effect of reducing the sensitivity to a considerable extent, but discrimination is improved, and the carbon monoxide and methane peaks are clearly separated. Higher hydrocarbons are well displaced from the ethylene peak, but were not present to any appreciable extent in the two gases tested.

There is an optimum length of absorption cell in the infra-red gas analyser for each compound, depending on the time taken to remove it from the column. For maximum sensitivity, the volume of the sample cell should equal approximately the total volume of nitrogen required to sweep the gas in question from the column, a longer cell merely broadens the band without increasing its height.

A. E. MARTIN
J SMART

Sir Howard Grubb, Parsons and Co.,
Optical Works,
Walkergate, Newcastle upon Tyne 6.

---

[1] James, A T, and Martin, A J P, *Biochem J*, 50, 679 (1952)
[2] Ray, N H, *J App Chem*, 4, 21 (1954)
[3] Ray, N H, *J App Chem*, 4, 82 (1954)

Permanent Dissociation of Sulphur Hexafluoride in Corona Discharges

THE high dielectric strength of sulphur hexafluoride has been measured by various workers, and many reasons for its existence have been put forward Because of its good insulating properties, sulphur hexafluoride is now used extensively in Van de Graaff generators and in gas-filled cables. The following experiments were carried out to find what permanent changes in molecular pattern, if any, could be observed when a corona discharge was run in sulphur hexafluoride and the products examined with a mass spectrometer. Clearly the results would be of interest in practical cases where corona discharges are present

Table 1

Ion	Relative abundance	Ion	Relative abundance
SF_5^+	100	SF_2^+	3 4
SF_4^+	9 3	SF^+	3 3
SF_3^+	22 8	F^+	1 3

There appear to be no published mass spectrometer studies of the permanent products of dissociation in electrical discharges in complex-attaching gases Schumb, Trump and Priest[1] passed corona and spark discharges through sulphur hexafluoride, noted pressure changes, as previous workers had done, and showed that potassium hydroxide solution dissolved some of, but not all, the dissociation products It was suggested that the insoluble gases were lower fluorides such as SF_4, SF_2 or S_2F_2 The pressure of sulphur hexafluoride was slightly greater than atmospheric, and corona discharge ran for periods of 50–200 hr with currents in the range 50–200 microamp

The relative abundances of the positive ions formed by electron bombardment in sulphur hexafluoride were determined using a 60° Nier-type mass spectrometer The sulphur hexafluoride, at a pressure of about half an atmosphere, was contained in a small glass discharge tube (30 c c capacity) with point–point tungsten electrodes, the gap spacing being 1 3 cm. The relative abundances were determined over a period of days for the same sample (Table 1), small beams of O_2^+, N_2^+, Hg^+, Hg^{++} and H_2O^+ were also present

The changes in abundance of the ion species were investigated for three different values of discharge current No attempt was made to calculate accurately these currents, nor to have the same conditions of pressure throughout the three trials, as it must be stressed that the investigations were made to find in a preliminary sense the changes taking place due to the discharge, rather than attempting an accurate quantitative investigation. After each of the three trial runs, the tube was thoroughly cleaned with a hot concentrated solution of sodium hydroxide to remove the silicates formed as a result of the discharge. The first discharge was run at 0 40 m amp (pulse frequency ~ 1/sec) for 15 min No appreciable change was observed in the abundances given in Table 1

The second discharge was run at ~ 60 m amp. (frequency ~ 1/sec) for two hours Mass spectrometer investigations showed that no SF_5^+, SF_4^+, SF_3^+, SF_2^+ or SF^+ were present, but that there was an increase in the intensity of the F^+ beam, and beams due to SiF_4^+, SiF_3^+, SO_2^+ were observed together with other beams of as yet unidentified ions

The third discharge was run at ~ 10 m amp. (frequency ~ 1/sec) for 30 min. Beams due to SF_5^+, SF_4^+, SF_3^+, SF_2^+ and F^+ were observed, together with those found in the second run Several measurements of relative abundances were made and the mean values of these determinations and those for the undischarged sulphur hexafluoride are compared in Table 2

Table 2

Ion	Relative abundance	
	Before discharge	After discharge
SF_5^+	100	100
SF_4^+	9 3	9 5
SF_3^+	22 8	24
SF_2^+	3 4	28
F^+	1 3	400–1,000

From these experiments, it is seen that under certain discharge conditions a change in the ion species of sulphur hexafluoride is observed, as would indeed be expected Although no attempt has been made to carry out a rigorous investigation, we have established the fact that appreciable permanent molecular dissociation accompanies the discharge, as shown by the increase in the F+ abundance in runs 2 and 3. This increase in F+ is to be expected, as the final products should clearly be sulphur and fluorine, but the completeness and speed of the reactions leading to the formation of fluorine are surprising.

The increase in the abundance of SF_2^+ is unexpected, as it would be thought more likely that the intermediate changes in the reaction $SF_6 \rightarrow S + 6F$ would involve changes in the relative abundances of SF_5^+, SF_4^+ and SF_3^+.

ROBERT THORBURN

Department of Electrical Engineering,
University, Liverpool
Nov. 11.

---

[1] Schumb, Trump and Priest, *Indust Eng Chem* 41, 1348 (1949)

A Molecular Approach to the Problem of Viscoelasticity

As a first step, the type of material considered is that coming under the generic heads of 'paper' and 'board'. These materials are made of cellulosic fibres which are filtered off as sheets from liquid suspensions and dried to give the final product. The bonds between the fibres are almost entirely made up of hydrogen bridges between cellulosic and hemicellulosic components.

The rheological curve obtained may be represented by Fig 1. The material has all the usual time-effects of viscoelasticity. Under constant load it creeps, and under constant extension it relaxes; consequently it shows hysteresis, and the stress/strain curve is dependent on the rate of application of load or the rate of stretching.

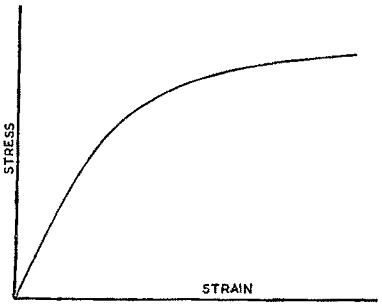


Fig 1 Stress-strain behaviour of paper

The theory proposed here is that when such a material is strained by $(\delta\sigma)$, showing a stress, f, the energy input $(f\delta\sigma)$ simply goes to raise the hydrogen bond potential from $-U_0$ at equilibrium to $(U = -U_0 + \delta U)$ Taking infinitesimal quantities, then,

$$f = dU/d\sigma. \qquad (1)$$

It only remains to select a function $U(\sigma)$ to evaluate (1). The Morse[1] function, rearranged from its usual form, is .

$$U = U_0 [\exp(-2a\sigma) - 2\exp(-a\sigma)] \qquad (2)$$

Thus, differentiating and expanding (2) gives

$$f = 2a^2 U_0 [\sigma - \frac{3}{2} a\sigma^2 + \frac{7}{6} a^2\sigma^3 - - -] \qquad (3)$$
$$= E\sigma - K\sigma^2 + - - - - ,$$

where $E = 2a^2U_0$ and $K = 3a^3U_0$. In these equations U_0 is in units of energy per unit volume, not per mole.

Equation (3) not only fits the curves obtained for these viscoelastic materials well, but also has the merit of depending on two parameters both of which should be, in principle, deducible from non-rheological data. Thus a can be evaluated rheologically as $(2K/3E)$ or spectroscopically from the infra-red absorption of cellulose. Rheological data give $a = 16·8 \pm 3$, whereas spectroscopy yields $a = 19·4 \pm 2$. The agreement may be considered as not unsatisfactory. Physically a is connected with that compressional strain σ^* which is necessary to raise the hydrogen bridge potential from $-U_0$ to zero, by $a = (\ln 2/\sigma^*)$. Similarly, U_0 is connected with the molar heat of dissociation of the hydrogen bond φ_0 by $[U_0/\varphi_0] = R$, where R is the number of moles of hydrogen bonds per cm ^{3} of tested material which are subjected to strain

According to this theory, time-effects are due to the fact that since the hydrogen bond is a weak link it breaks under strain. Thus R continually decreases with time and the problem resolves itself into a problem of chemical kinetics. Re-formation of the weak bonds gives rise to certain appearances of hardening under some conditions

The choice of the Morse function for the bond potential is somewhat arbitrary, other functions have just as much justification. It is a very convenient function for the purpose, but it suffers from one drawback. This function gives a maximum for f at a strain $\sigma = (\ln 2/a)$. Thus it cannot be applied for materials with $a \sim 20$ beyond a strain of 0·03 or thereabouts. For paper and board this is immaterial, as they normally break at lower strains, for other cellulosic materials this fact sets a limitation on the theory and equations. Cotton yarn, for example, does not yield such useful results as paper and board; probably other functions are required

I am indebted to Dr L Peters, of this Department, for many discussions and for the suggestion to use the Morse function. It is hoped to publish a more detailed treatment of this theory elsewhere.

ALFRED H. NISSAN

Department of Textile Industries,
University, Leeds 2.
Nov. 8

---

[1] Morse, P M, *Phys. Rev.*, 34, 57 (1929).

Infra-red Absorption Spectrum of Fluoropyruvic Acid

Mager and Blank[1] have reported the synthesis of fluoropyruvic acid and claim that its infra-red spectrum shows an absorption band at 980 cm $^{-1}$, which they assign to the C—F stretching vibration. This frequency is outside the range normally assigned to this vibration[2], and differs markedly from that suggested[3] and afterwards found[4] for this vibration in fluorocitric acid

An opportunity has recently occurred to examine a sample of fluoropyruvic acid synthesized by the

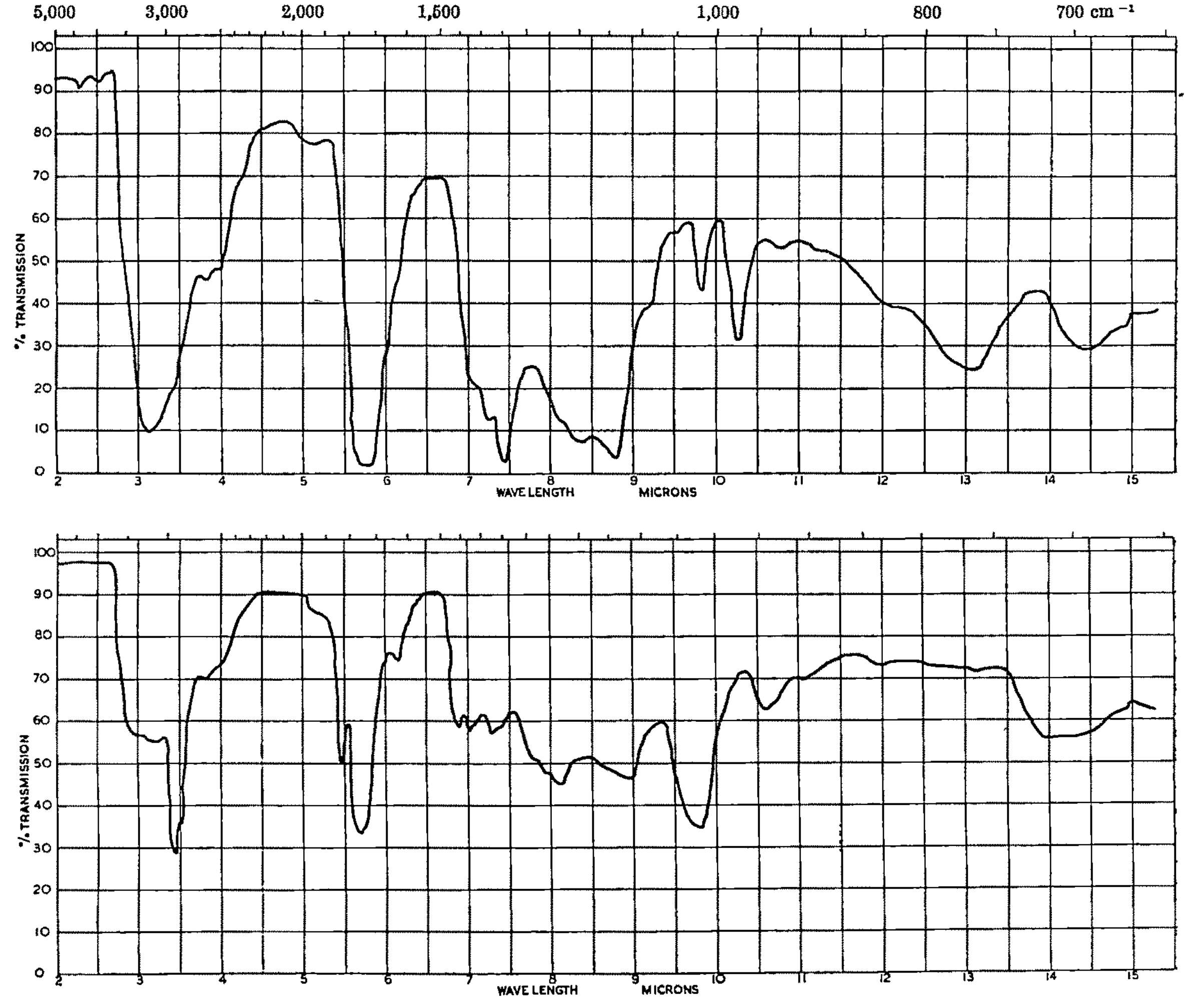


Fig 1 Upper spectrum, pyruvic acid, lower spectrum, fluoropyruvic acid

route described[1], and the infra-red absorption spectrum of the compound has been examined Comparison of its spectrum (Fig 1, lower) with that of pyruvic acid (Fig 1, upper) suggests that the band which should be assigned to the C—F stretching vibration occurs at 1,022 cm $^{-1}$ This is within the accepted frequency-range for this vibration and is in close agreement with the frequency of the corresponding band (1,026 cm $^{-1}$) in the barium salt of fluorocitric acid The absence of a band at the claimed frequency of 980 cm.$^{-1}$, and the observation that the wave-length of the observed band is 9 78 μ, suggest that the previous authors may have inadvertently quoted wave-length as wave-number.

This note is published by permission of the Chief Scientist, Ministry of Supply

L C. THOMAS

Chemical Defence Experimental Establishment
(Ministry of Supply),
Porton.
Nov. 9

---

[1] Mager, J, and Blank, I, *Nature*, 173, 126 (1954)

[2] Bellamy, L J, "The Infra-red Spectra of Complex Molecules", 270 (Methuen, 1954)

[3] Peters, R A, Wakelin, R W, Buffa, P, and Thomas, L C, *Proc Roy Soc*, B, 140, 497 (1952)

[4] Peters, R A, Wakelin, R W, Rivett, D E A, and Thomas, L C, *Nature*, 171, 1111 (1953)

Formation of Aquo Ions

IN two publications on this general topic, Bjerrum and Jørgensen[1], and Jørgensen[2], have reported on the absorption spectra in ethanol–water mixtures of cobaltous nitrate, among other salts. They conclude from their results that the spectral changes observed are due primarily to exchange between alcohol and water groups on the cation They suggest in particular[1,2] that the conclusions of Katzin and Gebert[3], based on studies with varied solvents and experimental conditions, to the effect that the spectral changes between water solution and solutions in organic solvents are due primarily to cation–anion complex interaction are therefore in error

The implication of the Bjerrum–Jørgensen interpretation is that the spectral effects discussed should be independent of the anion, when dealing with anions no more strongly complexing than nitrate ion. In particular, it would be expected that cobaltous perchlorate should show the same effects, since perchlorate is notoriously a poor complexing anion.

Fig 1 shows curves of optical density (1 cm. path-length) against wave-length for (*a*) aqueous cobaltous nitrate, (*b*) cobaltous nitrate in ethanol, and (*c*) cobaltous perchlorate in ethanol. All three refer to the same concentration of cobalt (0 0199 *M*), and the two alcoholic solutions have the same water con-

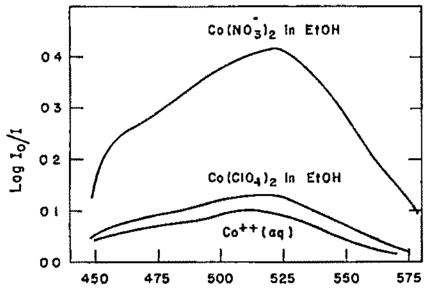


Fig 1

centration by Karl Fischer reagent titration (1 3 per cent). It is clear that the absorption of the alcoholic nitrate is more than four times that of the aqueous solution, whereas the perchlorate solution differs by less than 30 per cent from the aqueous spectral density.

Since measurements on nickelous nitrate have also been cited[2], we can furnish comparisons of perchlorate and nitrate spectra for this case too (Fig. 2) Instead of making solutions of both salts, however, we have added a lithium nitrate solution to the perchlorate solution, to make certain conveniently that the metal ion concentration is the same. The intensity relations are completely analogous to the cobalt situation, for both peaks of the nickel spectrum With copper[2], there is a bigger difference between the aqueous and the alcoholic perchlorate spectra than for the preceding (possibly related to a more ready formation of copper complexes with univalent anions) , but addition of lithium nitrate still increases the optical density, and shifts the spectrum.

We have also shown earlier[3] that shifts or intensity changes of the cobaltous nitrate spectrum larger than for ethanol solution are given not only in the alcohols heavier than ethanol, but also in acetone, which by all criteria is recognized as a weaker electron donor than the alcohols. Finally, it has also been shown in the cases of the nitrates discussed above that there is a drastic alteration of the characteristic absorption of the nitrate ion, when in alcoholic solution together with the cations listed, which is ascribable to some intense interaction such as would occur with complex formation[3,4].

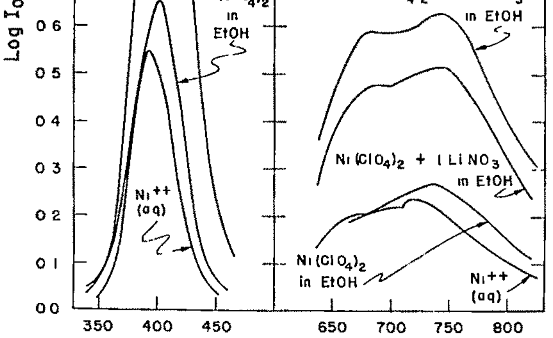


Fig 2

It seems a reasonable conclusion, the calculations of Bjerrum and Jørgensen notwithstanding, that the basic spectral alterations of the divalent cobalt, nickel and copper nitrates in ethanol solution are due to cation–anion interaction, and not primarily to water–alcohol replacement on the metal ion One might also raise a doubt whether this water–alcohol replacement hypothesis should be considered proved in other cases where the only evidence is agreement by calculation[1,2].

Leonard I Katzin
Elizabeth Gebert

Chemistry Division,
Argonne National Laboratory,
Lemont, Illinois

---

[1] Bjerrum, J , and Jørgensen, C K , *Acta Chem Scand* , 7, 951 (1953),

[2] Jørgensen, C K , *Acta Chem Scand* , 8, 175 (1954)

[3] Katzin, L I , and Gebert, E , *J Amer Chem Soc* , 72, 5457 (1950)

[4] Katzin, L I , *J Chem Phys* , 18, 789 (1950)

In the preceding letter, Katzin and Gebert are criticizing the conclusions drawn by us on the formation of aquo ions[1,2] The transition group elements were originally studied as nitrates in alcoholic solution, since the nearly anhydrous alcoholic solutions of perchlorates are liable to explode violently After the publication of the second paper[2], we have used perchlorates and other non-complexing salts and found qualitative agreement with the new results of Katzin and Gebert We do not agree, however, with all the conclusions drawn from these observations

At the maximum of the absorption band of cobalt(II) salts with non-complexing anions, the molar extinction coefficients ε are about 60 per cent higher in nearly anhydrous ethanol than in water, and not 30 per cent as measured by Katzin and Gebert in 0 7 *M* water solution Since cobalt(II) perchlorate, *p*-toluenesulphonate and trifluoroacetate all show the same spectra in ethanol and the same changes on addition of small quantities of water, it is most probable that these changes correspond to the real exchange of ethanol with water in the hexa-solvatized cobalt(II) ion, while we recognize that anion effects are superposed on the solvation effect by the much larger change in cobalt(II) nitrate solutions. Fig. 1 shows that cobalt(II) *p*-toluene-sulphonate has its mid-point of change by addition of water (in our opinion the average formation of $Co(H_2O)_3(C_2H_5OH)_3{}^{++}$) at a water concentration of about 2 0 *M* at 25° C , and the corresponding value for the nitrate is 0 92 *M* [2].

The strongly coloured compound in nearly anhydrous solutions of cobalt(II) nitrate is presumably not an electrostatic associate with the nitrate ion outside the solvation shell. Recently, the crystal field-theory has been applied to the absorption spectra of the transition group ions[3,4]. It is improbable that long-range effects will be observable in the spectra, and nitrato-complexes usually have their bands at slightly shorter wave-lengths than the corresponding aquo ions Experimentally, the electrostatic associates, which undoubtedly exist in cobalt nitrate solutions in carbon tetrachloride with

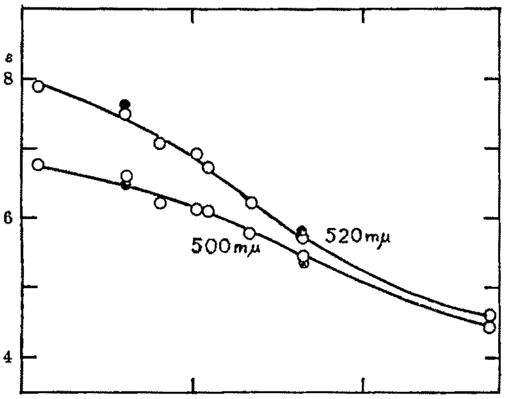


Fig 1 Molar extinction coefficient of cobalt(II) p-toluenesulphonate at 520 and 500 mμ as a function of the water concentration C_{H_2O} on a logarithmic scale

C_{Co} = 0 006 M (open circles) and 0 06 M (filled circles)

some water and ethanol, have been found[2] to have nearly the same spectrum as the pure aqueous solutions.

Fig. 2 shows the molar extinction coefficient of cobalt at 520 mμ as a function of the ratio between ammonium nitrate and cobalt, $C_{NO_3^-}/C_{Co}$ at different concentrations of cobalt(II) p-toluenesulphonate and water. (Measurements carried out at 500 and 480 mμ give analogous results.) It is seen from the slope of curve 1 that a mono-nitrato complex is formed with so large a formation constant (> 200) that dilution to 0 006 M cobalt has not much influence on the steep increase of ε caused by the nitrate first added at low concentrations of water. At larger values of $C_{NO_3^-}/C_{Co}$ there seems to be some difference at the same water concentrations, but the activity corrections for variable salt concentrations are difficult to estimate It is not certain that a di-nitrato complex is formed to any great extent, and the formation is at least far from complete at $C_{NO_3^-}/C_{Co} \sim 2$, as is also shown by the conductivity of cobalt(II)nitrate in ethanol[1] In the higher alcohols and ketones di-nitrato complexes are more stable, and colour is more intense than in ethanol, as is pointed out by Katzin and Gebert.

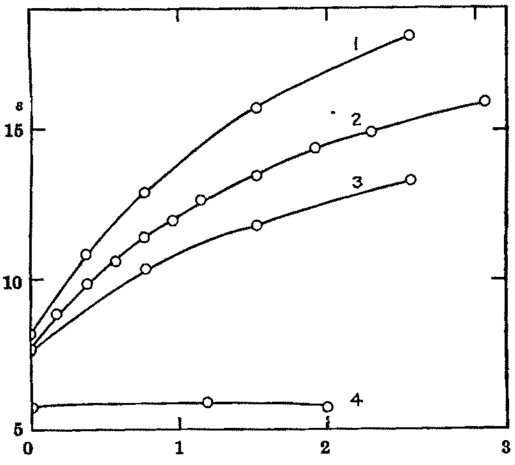


Fig 2 Molar extinction coefficient of cobalt at 520 mμ as a function of the ratio between the concentration of ammonium nitrate and of cobalt p-toluenesulphonate

Curve 1, C_{Co} = 0 006 M, C_{H_2O} = 0 08 M, curve 2, C_{Co} = 0 06 M, C_{H_2O} = 0 43 M, curve 3, C_{Co} = 0 006 M, C_{H_2O} = 0 43 M, curve 4, C_{Co} = 0 06 M, C_{H_2O} = 4 0 M

Curve 4 of Fig. 2 shows that at a water concentration of 4 M, a large excess of ammonium nitrate is without perceptible effect on the spectrum of cobalt(II) p-toluenesulphonate. Also ε at 520 mμ of a solution of 0 006 M cobalt, 0 36 M ammonium nitrate, is 23 4 at 0 1 M water, but only 6 2 at 4 M water. The order of affinity to the metal ion of ligands is, according to the term 'electron donor strength' of Katzin and Gebert

$$H_2O > NO_3^- > C_2H_5OH$$

which is a reasonable explanation of the strong influence of water on the complex equilibria. But since water is only eight times more strongly bound than ethanol[2] to cobalt(II) p-toluenesulphonate (where formation of anion complexes can scarcely be the explanation of the spectral change at a relatively large water concentration compared with the case of nitrate), the special tendency of the ethanol-solvatized cobalt ion to take up nitrate ions is peculiar Perhaps steric reasons are responsible for the easy removal of one or two of the alcohol molecules, while the hexa-aquo ion is more stable towards uptake of nitrate ions The stability of the nitrato-complex increases with the temperature This can be observed qualitatively in boiling ethanol, where the persistence of the strong colour on addition of water is remarkable

The nitrate ion has not such a disturbing influence in all of the cases investigated Bis(ethylenediamine)-copper(II) ions do not seem to show anion effects, since the perchlorate, the nitrate and the chloride have the same spectra in pyridine, which has a lower dielectric constant than ethanol and is bound more weakly than water to Cu en_2^{++}. The spectra of this ion in water, methanol, ethanol and pyridine are all different, showing no common non-solvatized form.

The suspicion thrown on solvation phenomena in general cannot be justified in the case of inner-complex salts without anions As will be shown later, nickel(II)bis(acetylacetonate) in benzene shows distinct changes of absorption spectrum by addition of ethanol (water precipitates the dihydrate), and nickel-(II)bis(formylcamphor)ethylenediimine in benzene is solvated by methanol.

Christian Klixbüll Jørgensen
Jannik Bjerrum

Chemistry Department A,
Technical University of Denmark,
Copenhagen

---

[1] Bjerrum, J, and Jørgensen, C Klixbull, *Acta Chem Scand*, 7, 951 (1953)

[2] Jørgensen, C Klixbull, *Acta Chem Scand* 8, 175 (1954)

[3] Bjerrum, J, Ballhausen, C J, and Jørgensen, C Klixbull, *Acta Chem Scand*, 8, 1275 (1954)

[4] Jørgensen, C Klixbüll, *Acta Chem Scand*, 8, 1502 (1954)

Ranges of Low-Energy Electrons in Protein

A KNOWLEDGE of the effective range of low-energy electrons in protein is of considerable biological interest. The ranges as calculated by Lea[1] from the Bethe theory of energy-loss cannot be accepted without experimental verification, since the validity of the assumptions made in the computations are questionable at the low energies. The sensitivity of small biologically active molecules to radiation can be used to measure the ranges by employing a layer of enzyme of thickness greater than the range of the electrons as an absorber. If a thin, uniform layer of dry enzyme is irradiated with a sufficiently large number of electrons, all the enzyme within the range of electrons is inactivated. After irradiation, the enzyme is assayed for remaining activity, knowing the amount inactivated, the surface area irradiated and the density of the material (taken as 1.3 gm./c.c.)[2] the range of the electrons in the enzyme can be found. Irradiations using the enzyme invertase[3] have already been carried out, and the ranges found were significantly less than those calculated by Lea. The size of the enzyme molecule itself prevented any measurements being made at energies less than 600 eV, for at that energy a layer one enzyme molecule in thickness was inactivated. The inaccuracies of the assay made the determinations at energies greater than 1,500 eV. uncertain.

These measurements have now been extended using deoxyribonuclease; the enzyme as well as the deoxyribonucleic acid for the assay were supplied by Worthington Biochemicals, Inc.; the assay was that of Kunitz[4]. Due to the smaller size of the molecule, accurate determinations of the ranges could be made down to energies of 300 eV. At energies smaller than this, the observed range became constant at a value of 60 A., corresponding to a layer one molecular diameter in thickness (see Fig. 1). High-energy radiation studies on deoxyribonuclease[5] have shown it to have a molecular weight of 62,000, and it is thought to be spherical with a diameter of 56 A. Between 300 and 1,500 eV, the range measurements agree remarkably well with those made using invertase. Above 1,500 eV, the ranges are in general somewhat lower than those given by the invertase measurements, showing a greater discrepancy from the theoretical curve.

The work of Alper[6] on the ranges of electrons in air, when corrected for the differences in density and stopping power between air and protein, also shows the experimentally determined ranges to be less than the theoretical values in the low-energy region. The quantum mechanical treatment of energy-loss is expected to break down when the velocity of the incident electron is such that the electron spends a finite length of time in the field of the absorber atom and therefore suffers one or more collisions. The experimental values are therefore more nearly correct for the ranges of low-energy electrons (delta-rays being of considerable interest) than those obtained by extrapolation of the curve valid at high energies

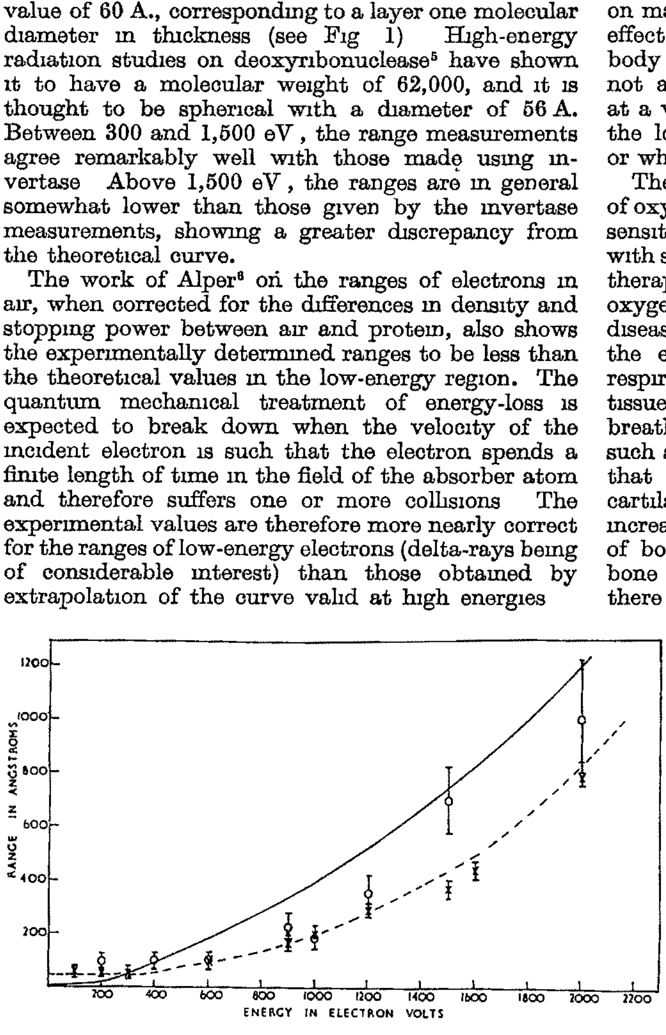


Fig. 1. ——, Theoretical curve, ----, experimental curve, ×, deoxyribonuclease, ○, invertase

This work was carried out during the tenure of a United States Public Health Service research fellowship of the National Cancer Institute.

MARGUERITE DAVIS
Department of Radiotherapeutics,
University of Cambridge.
Nov. 8.

[1] Lea, D. E., "The Action of Radiation on Living Cells" (Camb. Univ. Press, 1945).
[2] Adair, G. S., and Adair, M. E., *Proc. Roy. Soc.*, B, **120**, 422 (1936).
[3] Davis, M., *Phys. Rev.*, **94**, 245 (1954).
[4] Kunitz, M., *J. Gen. Physiol.*, **33**, 349 (1950).
[5] Smith, C. L., *Arch. Biochem. and Biophys.*, **45**, 83 (1953).
[6] Alper, T., *Z. Phys.*, **76**, 172 (1932).

Effect of Oxygen on the Radiosensitivity of Growing Bone and a Possible Danger in the Use of Oxygen during Radiotherapy

THAT oxygen tension has an effect on the radiosensitivity of living tissue has been known for many years, and the subject has been recently reviewed[1]. The effect was studied by Read[2], who established the form of the curve relating oxygen tension and radiosensitivity for a plant tissue. An essentially similar relation has been shown to hold for a wide variety of plant and insect tissues, though comparable data on mammalian tissue is still far from complete. The effect of partial anoxia on the lethal dose of whole-body irradiation has been investigated[3], but we are not aware of quantitative data on radiosensitivity at a variety of partial pressures of oxygen for either the local irradiation of tissue in the intact animal or whole-body irradiation.

The possibility that increasing the partial pressure of oxygen in the respired gas might improve the radiosensitivity of tumours differentially in comparison with surrounding normal tissue[4] has encouraged radiotherapists at a number of centres to administer oxygen to patients during radiotherapy for malignant disease. It has therefore become important to assess the effect of varying oxygen tension in the gas respired by mammals on the radiosensitivity of their tissues. While the change in radiosensitivity on breathing pure oxygen of a well-oxygenated tissue such as skin may not be large, there is the possibility that certain poorly vascularized tissues such as cartilage or bone might show a greater effect. This increase may be of particular concern in the case of bone. If the effectiveness of the irradiation on bone is increased because of a higher oxygen tension, there will be a greater risk of effects of high doses, such as necrosis, occurring after the delivery of the normal therapeutic dose[4]. This consideration will be of special importance if the treatment is given with X-rays from equipment working at a potential of 500 kV. or less, because of the greater absorption of energy in bone relative to soft tissue[5].

For these reasons we have made a study of the change of radiosensitivity of growing mammalian bone. The tails of groups of 7-day old *C57* black mice, breathing gas mixtures containing various partial pressures of oxygen, were irradiated with a single dose of 190 kV. X-rays. When anoxia of tissues was required, a cuff was fitted over the tail and a pressure of 280 mm. mercury applied. Three weeks later, the growth of the irradiated tails was com-

Table 1

	Anoxia	Partial pressure of respired oxygen (atmospheres)				
		0 1	0 2	0 4	1	3
Radiosensitivity* Standard error	0 0734 ± 0 0025	0 097 ± 0 006	0 145 ± 0 005	0 166 ± 0 009	0 188 ± 0 010	0 196 ± 0 009
Relative radiosensitivity Standard error	1 00 —	1 32 ± 0 10	1 97 ± 0 10	2 27 ± 0 15	2 56 ± 0 16	2 67 ± 0 13
Doses used (roentgens)	1,500 2,000 3,000	1,500 2,000	500 1,000 1,500	375 750 1 000	375 750 1,000	375 750 1,000

* ($\log_{10}$ control growth − $\log_{10}$ irradiated growth, mm)/dose K roentgens This formula is used to calculate the radiosensitivity because the curve relating growth with dose appeared to be more nearly exponential than linear

pared with that of litter-mate controls. Groups of six animals were used for each of three doses at each partial pressure of oxygen (except 10 per cent). The results of these experiments are given in Table 1.

The increase of radiosensitivity observed on changing the respired gas from air to oxygen at one atmosphere was 1 30 ± 0 06. Whether this factor applies to other tissues in mice or to analogous tissues in man remains to be seen However, the results presented here suggest that there may be danger in giving the same dose to a patient breathing oxygen that is normally given when breathing air. We hope to report the results more fully elsewhere.

P. HOWARD-FLANDERS
E A WRIGHT

Medical Research Council
Experimental Radiopathology Research Unit,
Hammersmith Hospital,
London, W 12.
Dec. 30

---

[1] Patt, H M., *Physiol Rev*, 33, 35 (1953)

[2] Read, J, *Brit J Radiol*, 25, 89 (1952)

[3] Dowdy, A H, Bennett, L R, and Chastain, S M, *Radiology*, 55, 879 (1950)

[4] Gray, L H, Conger, A D, Ebert, M, Hornsey, S, and Scott, O C A *Brit J Radiol*, 26, 638 (1953)

[5] Spiers, F W, *Brit J Radiol*, 22, 521 (1949)

Relation of Magnesium Supply to Growth and Net Assimilation-rate in Barley

IN recent years attention has been directed to the increasing incidence of magnesium deficiency in crop plants[1], and it is also possible that such a deficiency may cause disease in ruminants grazing on affected herbage[2]. Using the methods of growth analysis[3], a study is being made of the effect of this element on carbon assimilation in plants

Barley plants (var Plumage Archer) were grown in an unheated greenhouse in unaerated water cultures at eleven magnesium concentrations, varying from 0 to 300 p p m Magnesium was added as $MgSO_4 7H_2O$, the concentration of the sulphate radical being kept constant over the range of 0–100 p p m of magnesium, by the addition of sodium sulphate No sodium sulphate was added to the 300 p.p.m. solution Each treatment was replicated four times 300-ml soda glass jars were used, and three plants were grown in each The solutions were changed weekly and the *p*H adjusted to 6 0

The seed was sown in sand on March 26, 1954, and the seedlings transferred to water culture on April 8 Leaf areas and dry weights of whole plants were determined on April 8 and after 24 days growth in water culture Leaf areas were calculated using a leaf-index method[4]. At the end of the experiment the total magnesium content of the leaves was determined by the method of Mason[5].

Where the magnesium supply limited growth, some leaves died before the final sampling and others were completely chlorotic. Thus it seemed possible that differences between the net assimilation-rate of magnesium-deficient and normal plants might be due in part to the increased rate of senescence of the leaves of the former. In order to minimize this effect, the leaf areas of withered leaves at the final sampling date were not included in the final leaf areas Their dry weights were, however, included in the final dry weights This procedure was necessary for plants growing in solutions of magnesium concentration 0–1 23 p p m Thus the net assimilation-rate calculated for these plants will have been overestimated, since leaves dead at the final sampling date will have been actively assimilating at some time during the experiment. An abbreviated summary of the results is presented in Table 1, and graphically in Fig 1

Thus an increase in the concentration of magnesium in the nutrient solution from 0 41 to 3 7 p p m. resulted in a large and significant ($P < 0\ 001$) increase in net assimilation-rate and total dry weight. The magnesium concentration in the leaves of these plants increased from 0 07 to 0·12 per cent This also is a significant increase ($P < 0\ 001$) when the angular conversions of these values are statistically analysed. The net assimilation-rate did not vary significantly in plants in which the foliar concentration of magnesium ranged from 0 12 to 0 57 per cent.

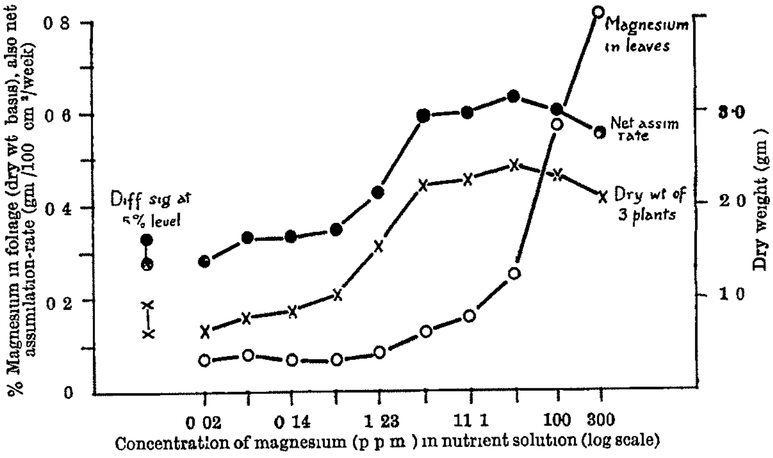


Table 1

Treatment	III	V	VI	VII	VIII	X	XI	Diff sign at 5 per cent level
Magnesium in nutrient sol (p p m)	0 05	0 41	1 23	3 7	11 1	100	300	
Final dry weight of 3 plants (gm)	0 80	1 05	1 57	2 20	2 27	2 31	2 09	0 23
Net assimilation-rate (gm /100 cm ²/ week)	0 33	0 35	0 42	0 59	0 59	0 60	0 55	0 05
Per cent magnesium in leaves (dry matter basis)	0 08	0 07	0 08	0 12	0 16	0 57	0 81	*

* An analysis of variance of the angular conversions of these values indicates that a significant difference ($P < 0\ 05$) exists between all treatments except between III, V and VI

The coefficient of variability for net assimilation-rate data in this experiment was 7 14 per cent.

It is tentatively concluded that the 'critical concentration'[6] of magnesium in young barley leaves is approximately 0 12 per cent. Below this value, both total dry matter accumulation and net assimilation-rate are reduced This work is being reported fully elsewhere

Acknowledgments are made to the Central Research Fund of the University of London for a grant in aid of equipment and to Dr I W. Selman for advice

T. F. NEALES
Department of Biological Sciences,
Wye College (University of London),
Ashford, Kent. Nov. 5

[1] Wallace, T , Ann Rep Long Ashton Res Stat , 24 (1940) Mulder, E G , and Smith, J , *Meded van Landbouwhoogeschool*, 46 (Wageningen) (1942) Thompson, F C , Ann Rep Dept Hop Res , Wye Coll (1949)
[2] Bartlett, S , *et al* , *Brit Vet J* , 110, 3 (1954).
[3] Gregory, F G , 3rd Ann Rep Exp and Res Stat Cheshunt, 19 (1917)
[4] Lal, K M , and Subba Rao, M S , *Science and Culture*, 15, 355 (1950).
[5] Mason, A. C , Rep E. Malling Res Stat , 1951, 126 (1952)
[6] Ulrich, A , "Ann Rev Plant Physiol ", 3, 207 (1952)

Occurrence of the Root-knot Eelworm, *Meloidogyne hapla*, out of doors in Great Britain

UNTIL recently, only one species of root-knot eelworm was recognized, namely, *Heterodera marioni* (Cornu). Renewed interest has been stimulated with the transfer of the eelworm to the genus *Meloidogyne* and the erection of a number of species[1]. In Great Britain, infestations of root-knot are most often recorded under glass, attacking tomatoes, cucumbers and various other glasshouse crops When attacks occurred in the open, it was usually assumed that the eelworm had originated from glasshouses. Some attacks occurred on sites where glasshouse soil was known to have been deposited, and these infestations appeared to die out fairly rapidly, usually within about two years, and Franklin[2] has shown that a population obtained from a glasshouse persisted out of doors in pots for at least sixteen months On other occasions, however, it has been difficult to associate the presence of the eelworm out of doors with a glasshouse source. Triffitt[3] has recorded an attack on carrots and parsnips on a field which, so far as could be ascertained, had not been contaminated with soil from glasshouses Since 1931 there has been a number of other records (*in litt*) of attacks in the open on various crops including carrots, parsnips, pyrethrums and scabious, but there must always be some doubt as to whether the eelworm had come from glasshouses

During the past three years, a number of severe attacks have occurred on various crops in several fields in the eastern counties of England. Here there was no possibility of contamination with glasshouse soil, and it was clear that these attacks were being caused by a species of *Meloidogyne* which thrived out of doors. The symptoms caused were quite distinct from those seen on glasshouse plants, the most striking difference being in the size of the galls Plants attacked by the species in glasshouses develop large galls with little or no root proliferation, whereas the galls from the outdoor attacks were small, usually not more than 3–4 mm. in diameter and often much smaller still, and on many hosts there was a large amount of root proliferation It is probable that the attack recorded by Triffitt was caused by the same species, as she also comments on the small size of the galls.

In the United States, of the species recognized at the moment, only *Meloidogyne hapla* can be identified by the type of galling produced on the plant. Plants attacked by this species develop symptoms similar to those described above for the outdoor attacks in the eastern counties of England, and it was considered most likely that this eelworm was identical with *M. hapla* Confirmation of this has now been obtained from Mr A L Taylor, Section of Nematology, U.S. Department of Agriculture, and it seems reasonable to assume that many of the earlier records also relate to this species, which has probably been long established in Great Britain

Severe damage has been caused to scabious (*Scabiosa caucasica*) on three fields on light sandy soil in the Mildenhall area of Suffolk. Well-established plants were being killed out by the eelworm. The galls were very small, and there was extensive root proliferation There have been complete failures of carrots, mangolds, sugar beet and kale on two fields in the Norfolk breckland, and light attacks on several other fields in the same area. On these plants the galls were also small , but the root proliferation

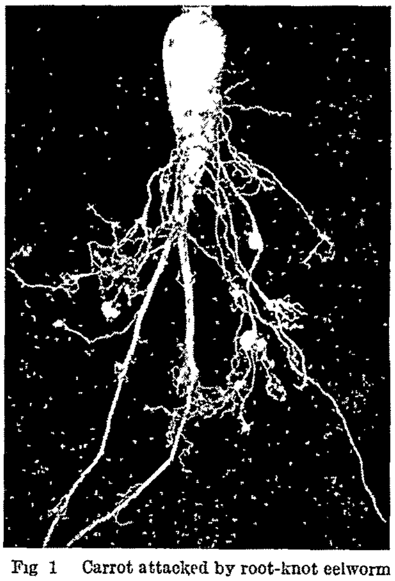


Fig 1 Carrot attacked by root-knot eelworm

was not so extensive as on the scabious Cereals are apparently immune from attack. This area also is very light sandy soil. A large number of weed species has been examined on some of these fields, and many of these are hosts

Thanks are due to Mr. N D N Welford, who has given considerable assistance with the field-work, and to Mr W E Dant for the photograph of the attacked carrot. Investigations into the host-range of this nematode are continuing, and full results will be published elsewhere

E B BROWN

National Agricultural Advisory Service,
Anstey Hall,
Trumpington, Cambridge.

[1] Chitwood, B G, *Proc Helm Soc Wash*, 16, 90 (1949)

[2] Franklin, M T, *J Helminth*, 15 75 (1937)

[3] Triffitt, M J, *J Helminth*, 9, 205 (1931)

Witchweed and Soil Fertility

JONES[1] has recently directed attention to a problem of considerable importance in African agriculture, namely, whether *Striga hermontheca* Benth. infestation is only serious on 'worn-out' soils or whether the 'wearing-out' is due to *Striga* itself.

An agricultural survey carried out in the southern Sudan has shown that, while on comparatively poor lateritic soils *Striga* is practically absent, it causes yield reductions of up to 70 per cent on rich alluvial clays. The reason for this seems simple, on the lateritic soils, soil nutrient exhaustion, due largely to erosion of the uppermost layer where nutrients accumulate under bush fallow, forces the native cultivator to abandon the field after a period of from three to five years, before *Striga* infestation can become serious Moreover, in the areas where these soils occur, good drainage and comparatively high rainfall permit diversified cropping. On the other hand, alluvial clay soils occur in the southern Sudan in areas of marginal rainfall and marginal drainage. *Sorghum*, which can tolerate both drought and, to a lesser extent, water-logging, is in these areas the only crop of major importance. Its cultivation is concentrated on sites less liable to flooding, and on such sites intensive and prolonged mono-cropping with *Sorghum* leads to increasing *Striga* infestation, in time causing serious deterioration of yields Where better drained land is more plentiful and shifting cultivation possible, *Striga* is regarded by the native cultivator as the main reason for abandoning old fields (usually after six to eight years)

Experiments carried out on heavy alluvial soils at Malakal[2] showed no significant response of *Sorghum* yields to application of fertilizers on recently abandoned 'worn-out' land. The comparison of yields of crops not parasitized by *Striga* grown on 'worn-out' land and newly opened-up land also shows no significant difference. On the other hand, owing to depredations of insect pests (mainly *Sorghum* stem-borer, *Sesamia cretica* Led), measures controlling *Striga* infestation resulted in no response in *Sorghum* yields.

Conclusions from the above observations can be summarized as follows (i) *Striga* infestation assumes considerable importance as a factor controlling yields in areas where sites suitable for cultivation, as well as the range of suitable crops, are limited. (ii) On inherently fertile heavy soils, damage due to this parasite reaches the critical level before the appearance of signs of soil exhaustion. (iii) *Striga* is only one of the evils of intensive and prolonged mono-cropping. Its control, for example by selective herbicides, can provide only a partial solution to the problem of *Sorghum* yield deterioration.

Though, in the southern Sudan, soil erosion is generally not serious on the clay plains, owing to lack of slope, on their margins where the slopes are greater, *Striga*, being one of the factors necessitating shifting cultivation, undoubtedly plays an important part in soil conservation. The introduction of an easy method of eradication might, in those areas, lead to over-cultivation and accelerated erosion, which would cause much greater and more permanent damage than the parasite itself.

J. J. BASINSKI

Southern Development Investigation Team,
Malakal, Sudan.
Oct. 5.

[1] Jones, K W, *Nature*, 172, 128 (1953)

[2] Jonglei Investigation Team "Equatorial Nile Project and its Effects in the Sudan", 3, 991 (1954)

A Nematode Parasite of *Drosophila*

ADULTS of *Drosophila* spp trapped at frequent intervals in Nature at Dalkeith, Midlothian, were dissected to follow the development of the ovaries, and occasionally the testes, during autumn, winter and spring. The flies dissected were *D subobscura* Coll. (19 males, 338 females), *D. obscura* Fln. (17 males, 92 females), *D. silvestris* Bas. (41 males, 34 females), *D. tristis* Fln. (2 males, 7 females), *D funebris* (Fabr.) (3 males, 11 females), and *D. cameraria* Hal. (3 females). During these dissections a few specimens of the first three species were observed to be infested with a nematode, provisionally identified as *Aphelenchulus* sp. (Allantonematidae Chtw. and Chtw., 1937), probably new. The numbers of dissected flies are shown in Table 1, the figures in parentheses being the numbers of those infested

Over the whole period of eight and a half months, 603 specimens of *Drosophila* spp. were dissected. There were 541 (+ ?36) specimens of the three infested species, of which 18(+1), or 3 3 per cent, were parasitized, the highest parasitism being in *D obscura.* Both sexes were infested All stages of the nematodes have been found in the abdomens of the flies gravid females (6 averaging 488 μ × 115 μ), eggs and young larvæ. As many as fourteen gravid females have been found within a single fly. Eelworm larvæ were sometimes especially abundant within the

Table 1

Date	*D sub-obscura* ♂	♀	*D obscura* ♂	♀	*D silvestris* ♂	♀	Totals
Sept 1953	—	2	5 (1)	10 (1)	18 (1)	13	48 (3)
Oct 1953	5	12	12 (2)	24 (2)	23	21 (1)	97 (5)
Nov 1953	1	69 (1)	—	5	—	—	75 (1)
Dec 1953	—	59 (1)	—	2	—	—	61 (1)
Jan 1954	—	37 (3)	—	3*(1)	—	—	40 (4)
Feb 1954	13	15	—	—	—	—	28 (0)
Mar 1954	—	88	—	3	—	—	91 (0)
April 1954	—	50 (1)	—	20 (2)	—	—	70 (3)
May 1954	—	6	—	25 (1)	—	—	31 (1)
(May 19, 1954)	(36 unidentified *obscura*-group (both sexes) dissected, only 1 (♀, *obscura*) with eelworms)						
Totals	19	338 (6)	17 (3)	92 (7)	41 (1)	34 (1)	

* Trapped in December but held over until January

ovaries, which latter were then stunted and the eggs were not developing. This situation is presumably the start of larval migration from the host. In the four infested males, however, the testes appeared normal and larval eelworms were not observed within these organs.

The larval eelworms showed the beginnings of differentiation into males and females. By analogy with other species of nematode parasites of insects, it appears possible that the larvæ come to maturity in a free-living state, outside the host. Possibly, also, it is the larva of *Drosophila* that is infested by the entry of spermatized but immature female eelworms, which gradually develop during the metamorphosis of the fly. Another nematode, *Tylenchinema oscinellae* Goodey, during the winter months parasitizes the larva of the fritfly (*Oscinella frit* L.) and passes over into the adult fly which emerges in May[1]. It is not known, however, whether larvæ of the above three species of *Drosophila* survive the winter, though Basden (unpublished) finds that *D. silvestris* passes this period in a puparium.

There appear to be two other records of parasitism of *Drosophila* adults by nematodes. Van Zwaluwenburg[2] cites Crawford as having found the larvæ of *Habronema megastoma* (Rud., 1819) (Spiruridae) in an undetermined species of Drosophilid in Ceylon in 1926, and Gershenson[3] found that most individuals of *D. melanogaster* Mg. and all those of *Parascaptomyza disticha* (Duda) (Drosophilidae) caught near Kiev were infested with a species of *Chondronema* (Allantonematidae).

The investigation is being continued in greater detail. We are grateful to A. A. Spence for many of the dissections.

E. B. BASDEN

Institute of Animal Genetics,
Edinburgh 9.

J. B. GOODEY

Rothamsted Experimental Station,
Harpenden, Herts.
Oct. 26

[1] Goodey, T., *J. Helminth.*, 8, (3), 123 (1930).

[2] Zwaluwenburg, R. H. van, *Bull. Hawaii Sug. Assoc., Ent. Ser.*, 20, 1 (1928).

[3] Gershenson, S., *Drosophila Inform. Serv.*, 11, 44 (1939).

A Method of isolating Vesicular Arbuscular Endophytes from Roots

THE exact systematic position of the vesicular arbuscular endophytes has been a topic of some controversy. In 1900 Dangeard[1] proposed the genus *Rhizophagus* for these fungi, and considered that they were closely related to the Endogonaceae, but that they had lost the ability to form compound fructifications. Peyronel[2] also considered that these endophytes closely resembled *Endogone*.

Nicholls[3], working in this Department, made a preliminary study of the endophyte present in the roots of *Allium ursinum* and pointed out the morphological similarity of this organism to certain Oomycetous fungi. From portions of root, surface sterilized with a solution of sodium hypochlorite, washed and placed on plain agar, she frequently isolated a strain of *Pythium ultimum*. Owing to the sensitivity of this fungus to the hypochlorite solution, this isolation technique often failed, while less severe surface sterilization of the roots allowed common soil fungi, notably species of *Fusarium*, which were probably present as surface contaminants, to develop on the isolation plates to the exclusion of *Pythium*.

A more direct method of isolation of the endophyte has now been devised. Roots are thoroughly washed under the tap and then transferred to a flask of sterile water in which they are vigorously shaken for a few minutes. This process is repeated three more times, after which longitudinal sections of the roots are cut under aseptic conditions. The sections are then transferred to a sterile coverslip and covered with a few drops of plain agar which contains 0.2 ml. aureomycin per 15 ml. of medium. The coverslip is then sealed on to a glass ring as in the preparation of a hanging-drop chamber. The sections are examined daily until one of the intercellular hyphæ grows out from the cut edge. This hypha is then picked up and transferred to a plate of plain or malt agar.

The washing treatment is successful in removing most of the contaminating rhizosphere fungi, as roots treated in this way show only occasional growth of common soil organisms, and the position of these on the surface of the section can easily be seen. The addition of aureomycin to the agar inhibits the growth of any bacteria still adhering to the root.

By the use of this method, *P. ultimum* has again been isolated from infected roots of *Allium ursinum*.

R. W. HARRISON

Department of Botany,
University of Bristol.
Nov. 12.

[1] Dangeard, P. A., *Botaniste*, 7 (1900).

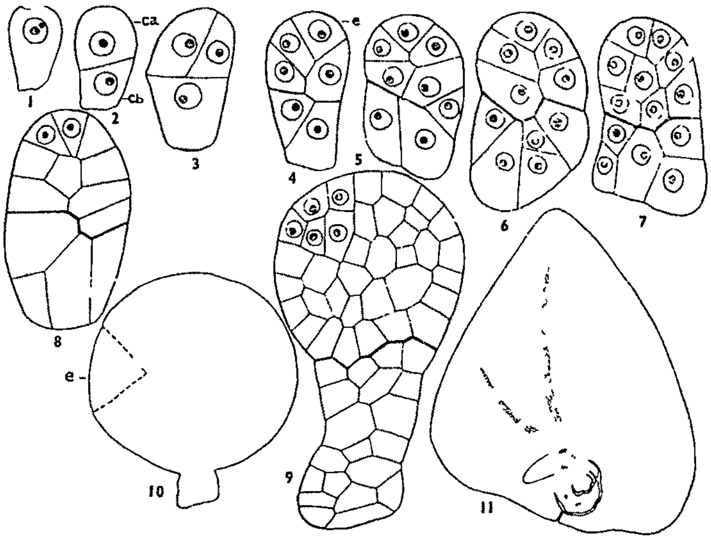
[2] Peyronel, B., *Bull. Soc. Mycol. France*, 39, 119 (1923).

[3] Nicholls, V. O. (Mrs. J. Sankey), thesis for the degree of Ph.D., University of Bristol (1952).

Embryo Development in Areca-nut

EMBRYO development in Palmae is unknown. There is only one description relating to the mature embryo of coconut, by Selvaratnam[1], who compared it with the embryo of Gramineae. The present communication describes the embryo development in *Areca catechu* L., commonly known as the areca-nut or betel-nut palm.

The first division in the fertilized egg (Fig. 1) is transverse and results in two cells *ca* and *cb* (Fig. 2). The latter divides first by a vertical wall and then in all planes. Its derivatives contribute to the formation of the suspensor, which becomes detached from the embryo proper in advanced stages. The terminal cell *ca* divides by an obliquely vertical wall resulting in two rather unequal cells (Fig. 3), the bigger of which undergoes a further division by a slanting wall. As a result, a triangular cell, the epiphyseal initial (Fig. 4 *e*), distinguishable from the rest by its shape and position, is formed. The derivatives of this cell give rise to the stem tip, while those of the sub-epiphyseal cells contribute to the formation of the cotyledon and the rest of the embryo proper. During the development of the embryo, there is a marked growth of the cotyledon on one side, resulting in the shifting of the position of the stem tip as shown in Figs. 5–10. As the embryo proper is exclusively derived from the products of *ca*, the embryo development in *Areca catechu* conforms to the onagrad type of Johansen[2]. So far the formation of an epiphysis in any monocotyledon showing the onagrad type is not known.



Figs 1–11. Embryo development in *Areca catechu*
Figs 1–8, × 300. Fig 9, × 250. Fig 10, × 120. Fig 11, × 10

The fully developed embryo (Fig. 11) is conical and measures 4–4.5 mm in length and 3–3.5 mm. in diameter at base. The single cotyledon completely encircles the plumule, leaving only a pore for its emergence during germination. The stem tip stands at an inclination of 170° to the long axis of the embryo and the root tip lies at 70° inclination to the stem tip. Both of them face the micropyle. The plumule shows several leaf primordia, each with some procambial strands. Vascular strands also extend nearly to the tip of the cotyledon from the procambial strands of the primary axis. The cells of the embryo are devoid of reserve food materials. The embryo is surrounded by copious ruminated endosperm in which hemicellulose and starch are stored.

I wish to thank the National Institute of Sciences of India for the award of a senior fellowship during the tenure of which this study was made, and also Prof. J. Venkateswarlu for his help and criticism.

C. Venkata Rao

Department of Botany,
Andhra University,
Waltair, India.
Sept. 28.

[1] Selvaratnam, E. M., *Nature*, 169, 714 (1952).

[2] Johansen, D. A., "Plant Embryology" (Waltham, Mass., 1950).

The Vector of an Outbreak of Kala-Azar in Kenya

It has recently been suggested that a new sandfly of termitaries, provisionally designated *Phlebotomus* (*Sergentomyia*) sp. nov. 2, may be the vector of an outbreak of kala-azar in Kenya Colony which has involved more than three thousand Africans[1]. Not only does the sandfly bite man, but also it is widely distributed throughout the epidemic area, and a small proportion are naturally infected with leptomonads in the anterior part of the mid-gut.

The purpose of this communication is to present further evidence incriminating this species. Previous attempts to infect specimens in the laboratory failed; but towards the end of December 1954, a few are believed to have become infected after being fed on the skin lesion of a patient with kala-azar. The lesion, first detected by Dr. P. E. Clinton Manson-Bahr (see following communication), was on the left shin of the patient and looked like a small healed tropical ulcer; it contained abundant *Leishmania*. Of seventy-five *P.* (*Ser.*) sp. nov. 2, fed in batches on the lesion, and dissected five to six days later, four, or approximately 5 per cent, contained leptomonads; three of the infections, all of which were scanty, had reached the anterior part of the mid-gut. Three of the positive sandflies were in a single batch of twenty-seven specimens, and if this batch had been the only one examined an infection-rate of 11 per cent would have been recorded. Five *P. clydei* (a sandfly of gerbil burrows regarded by Kirk and Lewis[2] as a possible vector in the Sudan) were also fed on the lesion but remained negative. During rather similar feeding experiments in the Sudan, the infection-rates for *P. orientalis* (believed to be the chief vector) and *P. clydei* were 7 and 1.8 per cent respectively, development also being of the anterior type[2]. It must be pointed out that the sandflies used in these experiments were 'wild-caught' specimens, and that some of the infections may have been previously acquired in Nature. The work should really be repeated using sandflies bred in the laboratory, but so far we have failed to rear *P.* (*Ser.*) sp. nov. 2 in captivity.

P. (*Ser.*) sp. nov. 2 has been shown to have a natural leptomonad infection-rate of only 1 per cent[1], the source of the leptomonads being uncertain. The sandflies used in the feeding experiments described in this communication were obtained from a termite hill in the kala-azar area, and ninety unfed specimens from the same site were negative on dissection. It therefore seems unlikely that the infections were previously acquired in Nature, although the possibility has not been entirely excluded.

It seems probable that *P.* (*Ser.*) sp. nov. 2 is the vector of the Kenya outbreak, though final proof is still lacking. The other anthropophilic species found in the kala-azar area occur in comparatively small numbers, and only bite man occasionally; none has yet been found infected with leptomonads in Nature.

I wish to thank the Director of Medical Services, Kenya, for permission to publish this communication.

R. B. Heisch

Division of Insect-Borne Diseases,
Medical Research Laboratory,
Kenya.
Jan. 24.

[1] Heisch, R. B., *Trans. Roy. Soc. Trop. Med. Hyg.*, 48, 449 (1954).

[2] Kirk, R., and Lewis, D. J., *Ann. Trop. Med. Parasit.*, 48, 33 (1954).

A Primary Skin Lesion in Visceral Leishmaniasis

Skin lesions containing Leishman–Donovan bodies in kala-azar have been recorded from the Sudan. Kirk and Sati[1], and Kirk[2], described a leishmanial skin lesion on the cheek which preceded visceral infection, and Petrov[3] claimed that, in Uzbekistan, kala-azar in children was preceded by skin ulcers.

Little is known about the method of penetration of the body by the *Leishmania* following the bite of the sandfly, and I would suggest that, in some cases at least, a primary skin lesion does occur at the site of the bite, with lymphatic spread to the regional glands and eventually to the viscera. The following case appears to support my hypothesis.

A male African (Mkamba) was admitted to hospital with a respiratory infection which responded to penicillin; when he felt well and was about to be discharged, a moderate generalized glandular enlargement was discovered which proved to be due to leishmaniasis. This was indeed a very early case of an otherwise symptomless and afebrile leishmaniasis. The axillary and groin glands were moderately enlarged. The spleen was palpable just below the left costal margin. The white cell count was 5,000 per c.mm., hæmoglobin 80 per cent and the formol-gel test slightly positive (solid opacity taking more than twenty minutes to develop). On the lower part of the left tibia was a skin lesion 3 cm × 6 cm with a central pink area, resembling a newly formed scar surrounded by a darker hyperpigmented zone. The central portion contained numerous *Leishmania*, and the outer darker area a few only. The left femoral gland was considerably enlarged and it, too, contained *Leishmania*. There were numerous parasites in the spleen, sternal marrow and glands. Blood culture was negative. A section of the lesion on the left tibia showed a central darker area just beneath the epidermis, which proved to be nests of intracellular *Leishmania* together with granulation tissue, large plasma cells, macrophages and newly formed blood vessels. The parasites were massed just beneath the epidermis. This distribution certainly suggests a primary initial leishmanial lesion at the site of the infective *Phlebotomus* bite, with regional glandular involvement and systemic spread.

In a recent series of nineteen untreated kala-azar cases two have shown similar lesions.

This observation is of importance as it suggests comparison with other protozoal diseases, such as trypanosomiasis (the trypanosome chancre).

I wish to thank the Director of Medical Services, Kenya, for permission to publish this communication.

P. E. C. Manson-Bahr

Nairobi, Kenya.
Jan. 3.

[1] Kirk, R., and Sati, M. H., *Trans. Roy. Soc. Trop. Med. and Hyg.*, 33, 501 (1940).

[2] Kirk, R., *Trans. Roy. Soc. Trop. Med. and Hyg.*, 32, 2, 271 (1938).

[3] Petrov, V. D., Parasitological symposium of Uzbekistan. Tashkent Inst. Epid. and Microbiol. and Trop. Inst., reviewed by C. A. Hoare, *Trop. Dis. Bull.*, 35, 134 (1938).

Use of Propylene Phenoxetol as a Relaxing Agent

Lamellibranchia are difficult to narcotize and then to fix without subsequent contraction of the tissues. It has been found that propylene phenoxetol can be used with considerable success to narcotize a variety of lamellibranchs. Using *Cardium edule*, the procedure was as follows. 5 c.c. of propylene phenoxetol was shaken vigorously with 15–20 c.c. of sea-water to produce a fine emulsion which was added to a breffit of sea-water containing actively siphoning specimens. Within half an hour the animals were completely relaxed with the foot protruding between the gaping shell valves and could be fixed in this condition without causing any contraction of the tissues. Sections of material treated in this way show no deterioration of the tissues and no loss of staining properties. Furthermore, relaxed animals, if washed and placed in fresh sea-water, recover and appear to function normally.

In addition to *Cardium edule*, propylene phenoxetol has been used successfully on *Nucula* spp., *Mytilus edulis*, *Arctica islandica*, *Glossus humanus*, *Spisula subtruncata*, and various members of the Veneridae. It is only partially successful with *Mya arenaria*.

Propylene phenoxetol is obtainable from the Nipa Laboratories, Ltd., Treforest, near Cardiff. It is used normally as an active agent against Gram-negative organisms, although Gough and Wentworth[1] found that it could also be used for restoring the natural colour to blood pigments after formalin fixation.

G. Owen

Department of Zoology,
University of Glasgow.
Nov. 10.

[1] Gough, J., and Wentworth, J. E., *J. Roy. Micr. Soc.*, 69, 231 (1949).

Observations on a Human Tumour in Tissue Culture

In the course of studying 140 human tumours in tissue culture, a rapidly proliferating strain of cells was obtained from epidermoid carcinomatous tissue, part of which came directly from the patient (*H.*) (Jan. 21, 1953) and part from an animal (rat) implantation (Sept. 5, 1952) of cells from the tumour, a slowly growing epidermoid carcinoma of the larynx. The cultures have maintained for two years a consistent growth-pattern closely resembling morphologically the malignant tissue from the patient. The strain, being the first permanent one developed in the series, has been designated the *A* strain. During the first few months of propagation, conditioned medium was employed from cultures made from patients *K.* and *F.*, having epidermoid carcinomas of the neck and cervix respectively. Because of the possibility of the presence of rat cells in the strain, a study (carried out by Dr. J. J. Biesele, Sloan-Kettering Institute, New York) of the chromosomes was undertaken, after a year in tissue culture, which indicated that the cells were of human origin, having characteristic *V*- and *J*-shaped chromosomes.

During the past year, a substrain has developed which can withstand long periods of starvation. The cells which emerge after transferring cultures which have received no attention or renewal of medium for several months are long, thin, small and thread-like. After transferring and feeding for several months, the cells again show the typical epidermoid cancer morphology. These cells, after reversion, are called *Af* (*A* strain fibroblastic) cells. These cells survive freezing at – 20° C. During the transition period, the cells assume a form indistinguishable from normal fibroblasts, and the type of colony changes accordingly. Almost no lysis takes place.

The cultures from which the *Af* strain was derived were made (Gey's technique) on Aug. 10, 1953. Ten *A* cell cultures were taken from the Sloan-Kettering Institute in New York to the Tuberculosis Immunization Research Centre at the State Serum Institute in Copenhagen. During a two-month period the cultures remained at room temperature without the fluid phase. On Oct. 5, 1953, the cultures were removed with trypsin and transferred. The fluid phase was added, and the cultures were rotated at 37° C. for one to two months with no further attention. On Nov. 12 one culture showed fibroblastic outgrowth and was transferred. As outgrowth occurred in other tubes, further transfers were made. The 'fibroblasts' grew actively, and several hundred subcultures were made during the ensuing months.

The fibroblastic cultures were transferred and fed in the routine manner, and gradually during a period of a few months reverted to the original strain pattern of epithelial carcinoma. The cells reverted during experiments done in January and February. By March and April the cells had completely reverted to type, after being dormant (looking like thin threads) or living as transitional fibroblasts for six to eight months. This process of converting dormant fibroblastic cells to active sheet-forming cells has been repeated regularly since then.

The 'hibernating' fibroblastic cultures accumulate large masses of fat.

The small, dormant, thread-like refractile cells in viable cultures which have received no media or attention for six to ten months might be considered a paramorphic type of cell, such as Hadfield[1] has discussed.

Apart from these fundamental observations, the cultures are of practical importance, as they constitute a large supply of stock material that requires no attention or media when not in use. The chance of losing the strain through accidental contamination is also lessened.

The fibroblastic cells appear to be resistant to agents that cause destruction of the epidermoid carcinomatous forms, such as the polio virus (Brunhilde strain obtained from Dr. Herdis von Magnus, State Serum Institute, Copenhagen) and chemical substances.

A more detailed report of the *A* and *Af* cells is in preparation.

AUDREY FJELDE

Tuberculosis Immunization Research Centre,
Statens Seruminstitut,
Copenhagen
Nov. 4.

---

[1] Hadfield, G., *Brit Med J*, ii, 607 (Sept 11, 1954). See also *ibid*, 635.

Biosynthesis of Hyaluronate

THE formation of hyaluronate by strains of Lancefield Group *A* and *C* streptococci growing in ordinary laboratory media was first shown by Kendall, Heidelberger and Dawson[1] and by Seastone[2]. More recently, it has been demonstrated[3] that the glucosamine and glucuronic acid moieties of hyaluronate are formed from glucose by cultures of these micro-organisms, without rearrangement of the carbon skeleton.

Previously we had reported[4] that glutamine specifically stimulates the formation of bound glucosamine, as hyaluronic acid, by washed preparations of group *A* streptococci incubated at 35° in a simple buffered glucose – salt solution of the following composition: 0·08 *M* sodium β glycerophosphate (anhydrous), 0·028 *M* glucose, 0·02 *M* magnesium chloride, 0·025 *M* inorganic phosphate buffer *p*H 7·0; the final *p*H of this mixture is 7·0. We now suggest, on the basis of further work using washed preparations, that the pathway for the synthesis of the glucosamine in hyaluronate by streptococci is

(*a*) NH_4^+ + glutamic acid → glutamine;
(*b*) Glutamine + glucose (or hexose derivative) → bound glucosamine + glutamate.

Evidence for this suggestion is as follows. (1) Glutamine or ammonium glutamate stimulates the formation of bound hexosamine in aged preparations of washed cells, but neither ammonia nor glutamic acid is separately effective. (2) Methionine sulphoxide, known to inhibit glutamine synthesis from ammonium glutamate in other systems[5], prevents synthesis of bound glucosamine in the presence of ammonium glutamate but not in the presence of glutamine. (3) A close relationship exists between the amount of glutamine or ammonium glutamate taken up by the cells and the bound glucosamine formed; at lower levels of nitrogen source the amount of bound glucosamine–nitrogen appearing approximates to half the total nitrogen supplied. (4) A cell-free extract of streptococci supplemented by 10^{-3} *M* adenosine triphosphate, 0·022 *M* cysteine, 0·025 *M* inorganic phosphate, 0·028 *M* glucose and 0·02 *M* magnesium ion formed glucosamine from glutamine but not from ammonium glutamate; it is not known whether this hexosamine is free or bound into mucopolysaccharide. (5) Very high (80–100 per cent) conversion of nitrogen-15 from ammonium ion into bound glucosamine nitrogen of hyaluronate has been shown in the presence of unlabelled glutamate.

This work, together with the similar observations of Leloir and Cardini[6] for the formation of glucosamine by *Neurospora* extracts, suggests that the above pathway is a general one for the synthesis of hexosamine, at least in micro-organisms. Full details of this work will be published elsewhere.

D. A. LOWTHER
H. J. ROGERS

National Institute for Medical Research,
The Ridgeway,
Mill Hill, London, N.W.7
Nov. 8.

---

[1] Kendall, F. E., Heidelberger, M., and Dawson, M. H., *J. Biol. Chem.*, 118, 61 (1937).

[2] Seastone, C. V., *J. Exp. Med.*, 70, 361 (1939).

[3] Roseman, S., Moses, F. E., Ludoweig, J., and Dorfman, A., *J. Biol. Chem.*, 203, 213 (1953). Roseman, S., Ludoweig, J., Moses, F. E., and Dorfman, A., *J. Biol. Chem.*, 206, 665 (1954). Topper, Y. J., and Lipton, M. M., *J. Biol. Chem.*, 203, 135 (1953).

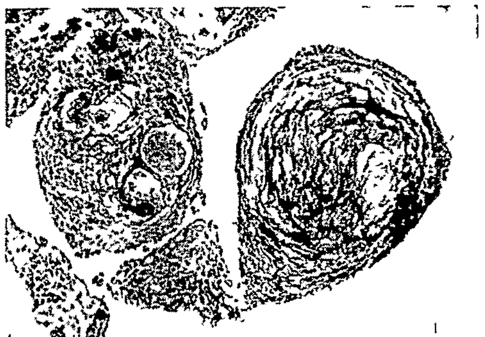
[4] Lowther, D. A., and Rogers, H. J., *Biochem. J.*, 53, xxxix (1953).

[5] Waelsch, H., Owades, P., Miller, H. K., and Borek, E., *J. Biol. Chem.*, 166, 273 (1946). Elliott, W. H., *Biochem. J.*, 49, 106 (1951). Elliott, W. H., and Gale, E. F., *Nature*, 161, 129 (1948). McIlwain, H., Roper, J. A., and Hughes, D. E., *Biochem. J.*, 42, 492 (1948).

[6] Leloir, L. F., and Cardini, C. E., *Biochim. et Biophys. Acta*, 12, 15 (1953).

Utilization of Sulphate Ion by Fibroblasts in the Quartz Focus

MUCOPOLYSACCHARIDES are abundant in healing wounds and other sites where collagen is forming, and Meyer[1] postulated their production in large quantities by fibroblasts. The mast cell has been credited with producing 'ground substance'[2] or hyaluronic acid[3], but Bunting and Bunting[4] recently reviewed much of the evidence for the source of mucopolysaccharide in fibroplasia and came to the conclusion that an origin from 'fibrocytes' seemed probable but not conclusive. Klemperer[5] expressed similar views; his objections were based largely on the non-specificity of the periodic acid – Schiff method for mucopolysaccharides. Gersh and Catchpole[6] had postulated previously a secretory cycle in



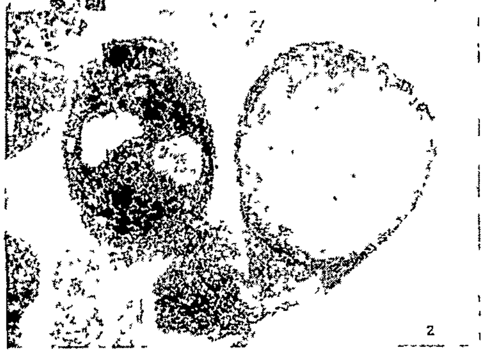


Fig 1 Silicotic foci of 51 days duration in the omental tissues The largest on the right consists mostly of dense collagen with fibroblasts at the periphery The other two are still largely fibroblastic with only early formation of collagen fibres Iron hæmatoxylin and Van Giesen × 80

Fig 2 Concentration of sulphur-35 is low in the mucopolysaccharide of the collagenous focus It is high in the fibroblasts at the periphery of this focus and in those of the cellular foci Autoradiograph × 80

fibroblasts dependent on the specificity of this technique.

Mucopolysaccharides are present in developing quartz foci, in the cytoplasm of fibroblasts and in unphagocyted dust[7] The large cells which invade and phagocytose the dust are stimulated to intense collagen production There is stainable mucopolysaccharide in their cytoplasm, and some is liberated into the focus

In autoradiographs, sulphur-35, given as sulphate ion, is 'fixed' only in the sulphated mucopolysaccharides of the tissues and is present in particularly high concentration within the cytoplasm of cells producing these Mammals are unable to incorporate the $^{35}SO_4$ ion into the sulphur-containing amino-acids, and the trace of sulphur-35 found in cystine is almost certainly formed by the animal's intestinal micro-organisms In this way the autoradiographic method determines accurately only those cells which elaborate mucopolysaccharide

Silicotic foci were produced in the peritoneal tissues of albino mice by the methods already described[7] and lesions of ages from 9 to 120 days were studied Sulphur-35 was administered as sulphate ion at pH 7 and autoradiographs prepared[3]

Sulphur-35 was taken up and retained within the developing quartz foci. Invariably the element was in high concentration only in the cellular fibroblastic zones (Figs 1 and 2) Where fibroblasts were widely dispersed, localization of the ion could be confirmed within their cytoplasm. Only low concentrations of sulphur-35 were present in the extracellular mucopolysaccharide, particularly when this was accompanied by abundant collagen fibres Testicular hyaluronidase (Benger's 'Hyalase') had no effect on the distribution of the radioactive ion. In view of the specific nature of the location of the $^{35}SO_4$ ion within the cytoplasm of cells forming mucopolysaccharide[8], the evidence presented here strengthens greatly the belief that fibroblasts do form and secrete mucopolysaccharides into the surrounding tissues during collagen formation.

R C. Curran
J S Kennedy
University Department of Pathology,
Royal Infirmary,
Glasgow.
Nov 8

---

[1] Meyer, K , *Physiol Rev* , 27, 335 (1947)
[2] Sylvén, B , *Acta chir Scand* , 86, Supp 66, 1 (1941)
[3] Asboe-Hansen, G , *Cancer Res* , 13, 587 (1953).
[4] Bunting, C H , and Bunting, H , *Arch Path* , 55, 257 (1953)
[5] Klemperer, P , *Amer J Path* , 26, 505 (1950) , *Bull New York Acad Med* , 28, 204 (1952)
[6] Gersh, I , and Catchpole, H R , *Amer J Anat* , 85, 457 (1949)
[7] Curran, R C , *Brit J Exp Path* , 33, 82 (1952) , *J Path Bact* , 66, (1), 271 (1953)
[8] Curran, R C , and Kennedy, J S , *J Path. Bact.* (in the press)

"Animal Cytology and Evolution"

We were surprised at the content, and still more at the tone, of the review by Prof. C D. Darlington of M J. D White's "Animal Cytology and Evolution"[1] In our opinion, it would be unfortunate if the many criticisms given under the authority of Darlington's name were allowed to obscure what seem to us the merits of this book White's book contains not only a most useful and critical compilation of scattered data, but also many stimulating discussions of a variety of topics , and it is a valuable part of Dr. White's work that he makes it clear which of his remarks are intended to be factual and which theoretical.

C. H. Waddington
Institute of Animal Genetics,
Edinburgh
H. G Callan
Department of Natural History,
St Andrew's.
Feb. 7.

[1] "Genetics and the Chromosomes", *Nature*, 175, 4 (1955).

"Independence in Publication"

The subject of Prof. A. V. Hill's communication[1] is one of long standing.

Prof. Elliott Coues published a "Handbook of Field and General Ornithology" in 1890[2] in which he gives instructions for the collection of specimens He lists all the details that should be recorded on labels, including "Name of the person in charge of the [survey, voyage, exploration, or other expedition (if any), during which the specimen was collected] (and it may be remarked that the less he really cares about birds, and the less he actually interests himself to procure them, the more particular he will be about this)."

L. Harrison Matthews
Zoological Society of London,
Regent's Park,
London, N W 1.
Feb. 10.

[1] *Nature*, 175, 266 (1955)
[2] Coues, E , "Handbook of Field and General Ornithology" (Macmillan, London, 1890)

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, March 7

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m—Dr W E Ripper "Spraying of Crops by Helicopter"

Society of Chemical Industry, London Section (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m—Mr J Wright "Utilization of Fission Product Radiation"

Royal Institute of Chemistry, London Section (joint meeting with the Woolwich Polytechnic Scientific Society, at the Woolwich Polytechnic, London, S E 18), at 7 30 p m—Mr L C Nickolls "Some Chemical Aspects of Forensic Science"

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 30 p m—Mr Merlin Minshall "Sailing Across Europe"

Tuesday, March 8

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 5 p m—Mr J W McPherson "Some Non-Linear Magnetic Devices and their Application to Telecommunications"

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N W 1), at 5 p m—Scientific Papers

Institution of Civil Engineers (at Great George Street, Westminster, London, S W 1) at 5 30 p m—Mr D R R Dick "The Civil Engineer and Britain's Atomic Factories".

University of London (in the Meyerstein Lecture Theatre, Westminster Medical School, Horseferry Road, London, S W 1), at 5 30 p m—Academician W A Engelhardt (U S S R) "Mechano-Chemistry of Muscle" * (Further lecture on March 16)

Institution of the Rubber Industry, London Section (joint meeting with the Plastics Institute, at the "Oversea" League, Park Place, St James's, London, S W 1), at 7 p m—Dr A Charlesby "Changes in Rubber-like Materials by Exposure to High Energy Radiation"

Wednesday, March 9

Institute of Petroleum (at 26 Portland Place, London, W 1), at 5 30 p m—Mr L Grunberg "The Viscosity of Liquid Hydrocarbons" *

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W C 2), at 5 30 p m—Dr P E Axon, Mr C L S Gilford and Mr D E L Shorter "Artificial Reverberation"

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 5 30 p m—Prof T M Sonneborn (University of Indiana) "Paramecium in Modern Biology" * (Further lectures on March 10 and 11)

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 5 30 p m—Dr C R Skoglund (Stockholm) "The Functional Organization of Spinal Interneurones" * (Further lecture on March 11)

Illuminating Engineering Society (at the Royal Institution, Albemarle Street, London, W 1), at 6 p m—Sir Harold Spencer Jones, F R S "The Brightness of the Stars" (Third Trotter-Paterson Memorial Lecture)

University of London (in the Beveridge Hall, Senate House, London, W C 1), at 6 p m—Sir Henry Tizard, F R S "A Scientist In and Out of the Civil Service" * (Haldane Memorial Lecture)

Society of Chemical Industry, Food Group (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m—Dr E C Barton-Wright "The Problem of Protein Haze in Bottled Beer", Dr E H Callow "Factors Affecting the Water Content of Meat"

Thursday, March 10

British Society for the History of Science, Philosophy of Science Group, Northern Branch (at the University, Nottingham), at 4 30 p m—Dr J O Wisdom "Is the Philosophy of Science a Science ?"

Physical Society, Low Temperature Group (in the Science Museum Lecture Theatre, Exhibition Road, London, S W 7), at 4 30 p m—Dr G G Haselden "Some Experimental Problems Encountered in the Fractionation of Liquid Air"

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 5 30 p m—Dr W Gumz "Fuel Developments in Germany" *

Royal Meteorological Society (in the Conference Hall, County Hall, Westminster Bridge, London, S E 1), at 5 30 p m—Mr F Ludlam "Clouds" * (Meeting open to Sixth-form Scholars)

University of London (at King's College, Strand, London, W C 2), at 5 30 p m—Prof P M S Blackett, F R S "War and Scientific Development" * (Last of a series of lectures on "War and Society")

University of London (at Senate House, London, W C 1), at 5 30 p m—Dr P Karrer (University of Zurich) "Curare-Alkaloids" * (Further lecture on March 11)

Institution of Mechanical Engineers, Industrial Administration and Engineering Production Group (at 1 Birdcage Walk, Westminster, London, S W 1), at 6 45 p m—Discussion on "The Engineer as an Administrator"

Royal Institute of Chemistry (joint meeting with the West Ham College of Technology Chemical Society, at the West Ham College of Technology, Romford Road, London, E 15), at 7 p m—Prof H J Emeléus, F R S "Fluorine".

Friday, March 11

Bedson Club (in Lecture Theatre I, New Chemistry Building, King's College, Newcastle upon Tyne 1), at 5 30 p m—Prof F J W Roughton, F R S "Rapid Reactions of Hæmoglobin with Oxygen and Carbon Monoxide" (99th Bedson Lecture)

South Place Ethical Society (at Conway Hall, Red Lion Square, London, W C 1), at 7 30 p m—Lord Boyd-Orr, F R S "Ethics in the Atomic Age" (Conway Memorial Lecture)

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m—Sir Arnold A Hall, F R S "Experimental Techniques Used in Aeronautical Research and Development"

Saturday, March 12

Nutrition Society (at St Mary's Hospital Medical School, London, W 2), at 10 45 a m—Symposium on "Alcohol and its Nutritional Significance"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer (with a good honours degree or Associate of the Royal Institute of Chemistry, and with research and/or industrial experience) in Chemistry, and a Lecturer (with a good honours degree or Associate of the Institute of Physics, and with research and/or industrial experience) in Physics, at the Technical College of Monmouthshire, Crumlin, Newport—The Director of Education, County Hall, Newport, Mon (March 12)

Senior Research Officer (with a degree in agricultural science or science of an Australian university, or of an overseas university of equivalent standing, or equivalent qualifications which should include a university degree supported by special postgraduate experience in research and/or teaching in plant pathology), in the Plant Quarantine Section, Department of Health, Canberra, for research and investigation into matters affecting plant quarantine involving liaison and co-operation with appropriate institutions and technical workers in Australia—Chief Commonwealth Medical Officer, Australia House, Strand, London, W C 2 (March 19)

Assistant Experimental Officer (male) (graduate in botany or agricultural botany, with training in plant physiology and preferably some knowledge of modern methods of field experimentation), in the Botany Department to help in field work on the physiological analysis of growth and yield of agricultural crops, and in related laboratory work—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting "102" (March 21)

Chair of Zoology at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W C 1 (March 21)

Lecturer (with a good honours degree or equivalent qualification in mechanical engineering, and with practical experience in industry and in teaching) in Mechanical Engineering—The Principal, Wigan and District Mining and Technical College, Wigan (March 21)

Senior Lecturer or Lecturer in Physiology at the University College of the West Indies—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W C 1 (March 21)

Research Assistant (preferably with an honours degree in medical sciences or biology, and a knowledge of German) in the Department of Anatomy, for work mainly on the central nervous system—The Secretary, University College, Gower Street, London, W C 1 (March 26)

Research Assistant (with a first- or good second-class degree in botany, with ecological and physiological interests) in Ecology—The Secretary and Registrar, The University, Southampton (March 26)

Research Officer (with an honours degree in engineering or science or equivalent qualifications) in the Division of Building Research, Commonwealth Scientific and Industrial Research Organization, Highett, Victoria, Australia, to participate in a programme of theoretical and experimental research on the properties and uses of lightweight concrete and gypsum plaster as structural materials—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting 390/209 (March 26)

Assistant Lecturer (preferably with interests in applied mathematics) in the Department of Mathematics—The Secretary, University College London, Gower Street, London, W C 1 (March 28)

Lecturer in Refractory Materials in the Department of Metallurgy—The Registrar, The University, Sheffield (March 31)

Senior Lecturer in Electrical Engineering at the University, Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Adelaide, March 31)

Scientific Officer (with a first- or second-class honours degree in an approved scientific subject or other approved equivalent qualification) in the Department of Industrial and Forensic Science of the Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast (April 1)

University Demonstrator (with an honours degree in some branch of natural science, and preferably with a veterinary qualification and experience in teaching the subject) in Veterinary Anatomy—Dr A S Watt, Botany Department, Downing Street, Cambridge (April 1)

Chair of Applied Mathematics—The Registrar, The University, Sheffield 10 (April 2)

Research Fellows, for independent research—The Registrar, The University, Reading (April 12)

READER or SENIOR LECTURER IN APPLIED MATHEMATICS at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Hong Kong, April 15)

I C I RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W C 1 (April 16)

TURNER AND NEWALL RESEARCH FELLOWS IN ENGINEERING, INORGANIC CHEMISTRY, PHYSICS or an allied subject—The Academic Registrar, University of London, Senate House, London, W C 1 (April 16)

ASSISTANT LECTURER (honours graduate in botany or agricultural botany) IN AGRICULTURAL BOTANY—The Registrar, The University, Reading (April 30)

RESEARCH ASSISTANT (with a medical degree or an honours degree in physiology or zoology) IN THE CLIMATIC AND WORKING EFFICIENCY UNIT of the Medical Research Council, Department of Human Anatomy, University of Oxford, to take part in fundamental studies of muscle and joint action and the application of this to clinical, industrial and service problems—Prof Sir Wilfrid Le Gros Clark, F R S , Department of Human Anatomy, University Museum, Oxford (April 30)

RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY for work on heterogeneous catalysis—Prof C Kemball, Queen's University, Belfast (April 30)

ASSISTANT PROFESSOR OF SOIL SCIENCE—Head of the Department of Soil Science, Faculty of Agriculture, University of Alberta, Edmonton, Alberta, Canada (May 1)

ASSISTANT LECTURER, Grade B (with a good honours degree in physics or electrical engineering, and with some research, industrial or teaching experience) IN THE DEPARTMENT OF APPLIED PHYSICS, College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff

CHEMIST or BIOLOGIST (with at least a second-class honours degree in chemistry or biology, and a good knowledge of chemical analysis) IN THE HEALTH PHYSICS DIVISION, to undertake work on the uptake and metabolism of radioactive elements in biological materials—The Establishments Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/237

FISHERIES OFFICER (with a university degree in natural science, preferably zoology) in the Lake Victoria Fisheries Service, East Africa High Commission, for duties which include the development and control of the fisheries of Lake Victoria—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1 quoting BCD 65/88/01

LECTURER Grade B (graduate of a British university with chemistry as one of the major subjects, and preferably with a knowledge of nutrition or hygiene), to teach Science as applied to Catering and allied subjects—Clerk to the Governing Body, Battersea Polytechnic, London, S W 11

RESEARCH ENGINEER (about 27 years, with an honours degree in engineering and one or two years practical experience) IN THE RESEARCH AND DEVELOPMENT DIVISION of the Cement and Concrete Association, near Slough, to work on concrete materials and methods of construction—The Secretary, Cement and Concrete Association, 52 Grosvenor Gardens, London, S W 1

SENIOR SOIL CONSERVATION OFFICER (with a university degree in an appropriate subject, and at least one years postgraduate study or experience of soil conservation) IN THE DEPARTMENT OF AGRICULTURE, Gold Coast Local Civil Service, for duties which comprise the planning, administration and execution of schemes for soil conservation and land utilization, and the tendering of advice on problems of soil conservation—The Director of Recruitment, Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 63/13/017

SOIL SURVEY OFFICER (with a degree either in geography, or in science with geology or geography as one subject) IN THE DEPARTMENT OF AGRICULTURE, Western Region, Nigeria, to take part in the field work of a scheme of systematic classification and mapping of soils—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 63/410/02

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

London and Home Counties Regional Advisory Council for Higher Technological Education Bulletin of Special Courses in Higher Technology (including Management Studies and Commerce), 1954–55 Part 2 Spring and Summer Terms, 1955 Pp v+41 (London London and Home Counties Regional Advisory Council for Higher Technological Education 1954) 1*s* 6*d* [1712

British Gelatine and Glue Research Association Sixth Annual Report for the year October 1953 to September 1954 Pp 15 (London British Gelatine and Glue Research Association, 1954) [1712

Royal Entomological Society of London Handbooks for the Identification of British Insects Vol 4, Part 8 (a) Coleoptera—Staphylinidae Section (a) Piestinae to Euaesthetinae By the Rev C E Tottenham Pp 79 (London Royal Entomological Society of London, 1954) 15*s* [1712

The Nuffield Foundation Report for the year ended 31 March 1954 Pp 141 Report on grants made during the ten years April 1943 to March 1953 Pp 319 (London The Nuffield Foundation, 1954) [2112

Royal Institute of Chemistry Lectures, Monographs and Reports 1954 No 6 A Physical Approach to Terpenoid Strictures By Prof J Monteath Robertson (Third Henderson Memorial Lecture) Pp ii+21 (London Royal Institute of Chemistry, 1954) [2112

Anti-Locust Research Centre Anti-Locust Bulletin No 18 Sexual Maturation in the Desert Locust (*Schistocerca gregaria* Forskål), with special reference to the Effects of Grouping By Dr Maud J Norris Pp ii+46 (London Anti-Locust Research Centre, c/o British Museum (Natural History), 1954) 4*s* 6*d* [2112

Ministry of Fuel and Power Safety in Mines Research Establishment Thirty-second Annual Report on Safety in Mines Research, 1953 Pp 83+4 plates (London H M Stationery Office, 1954) 3*s* net [2112

Other Countries

Geological Map of East Africa (Dar-es-Salaam Department of Lands and Surveys, 1954) [1512

U S Department of Commerce—National Bureau of Standards N B S Circular 549 Computation of Achromatic Objectives By Robert E Stephens Pp 7 (Washington, D C Government Printing Office, 1954) 10 cents [1512

New York University—College of Engineering Meteorological Papers Vol 2, No 3 (June 1954) The Atmospheric Lunar Tides By Ryukichi Sawada Pp 31 (New York New York University Press, 1954) 1 50 dollars [1512

Birds the World Over By Austin L Rand and Emmet R Blake Pp 97 (Chicago Natural History Museum, 1954) 1 50 dollars [1512

Reports of the Biochemical Research Foundation of the Franklin Institute Vol 12 1952–1953 , with an Index to B R F Publications Nos 1 to 263, and B R F Notes, Nov 1938 to Dec 1953 , Bound in Reports from the Biochemical Research Foundation, Volumes 1 to 12, 1930–1953 Pp 154 (Newark, Delaware Biochemical Research Foundation of the Franklin Institute, 1954) [1512

Canada—Department of Mines and Technical Surveys Map of Canada Principal Mining Areas and Producing Mines (Map 900A, Fourth edition) (Ottawa Queen's Printer, 1954) [1512

Southern Rhodesia Geological Survey Bulletin No 41 The Geology of the Country between Concession and Msonneddi (Mazoe District) By J G Stagman Pp vii+48+4 plates (Salisbury Government Printer, 1953) [1512

Publications de l'Institut National Turc de Bibliographie Bibliographie des Articles Parus dans les Periodiques Turcs, 1953 (4–6—Avril–Juin) Pp 13 (Istanbul Maarif Basimevi, 1954) [1512

Metropolitan Life Insurance Company, Statistical Bulletin, Vol 35, No 10 Chances of Death in a Family Pp 12 (New York Metropolitan Life Insurance Company, 1954) [1512

U S Department of Agriculture Leaflet No 368 The Alfalfa Weevil How to Control It Pp 8 (Washington, D C Government Printing Office, 1954) 5 cents [1512

Tanganyika Geological Survey Department Bulletin No 25 The Geology of the Galula Coalfield, Mbeya District By J Spence Pp iv+35 (Dar-es-Salaam Government Printer, 1954) 8 shs [1512

Canada Defence Research Board The Earth's Exterior Atmosphere and the Counterglow The Counterglow as Related to Modern Geophysical Theories, with seven recent Russian papers collected and translated by E R Hope Second edition Pp xxviii+52 (T 65 R) (Ottawa Defence Research Board (Defence Scientific Information Service), 1954) [1512

Centre National de la Recherche Scientifique Le Laboratoire Souterrain du Centre National de la Recherche Scientifique a Moulis (Ariège) Pp 24 Centre d'Études de Chimie Métallurgique, Vitry-sur-Seine (Seine) Pp 70 (Paris Centre National de la Recherche Scientifique, 1954) [1512

Meddelande Från Lunds Astronomiska Observatorium Ser 1, Nr 187 Metagalactic Distance Indicators and Spatial Distribution of Galaxies By Knut Lundmark Pp 195–210 (Lund Hakan Ohlssons Boktryckeri, 1954) [1512

Arkiv for Astronomi Utgivet av Kungl Svenska Vetenskapsakademien, Band 1, Nr 35 On the Resolving Power of the Photographic Image with Special Regard to the Developer By Nils Hansson (Meddelande Fran Lunds Observatorium, Ser 1, Nr 182) Pp 12 (Stockholm Almqvist and Wiksells Boktryckeri , London H K Lewis and Co , Ltd , 1954) [1512

Commonwealth of Australia Commonwealth Scientific and Industrial Research Organization Sixth Annual Report for the year ending 30th June 1954 (1953–54) Pp vi+372 (Melbourne Commonwealth Scientific and Industrial Research Organization, 1954) [1512

Bulletin of the Astronomical Institutes of the Netherlands Vol 12 No 456 (1954, November 22) The Acceleration of Interstellar Clouds By F D Kahn Pp 187–200 Vol 12, No 457 (1954, November 30) The Dependence of Interstellar Absorption of Light on the Wavelength By J Borgman Pp 201–210 Vol 12 No 458 (1954, December 1) The Rotation of the Inner Parts of the Galactic System By K K Kwee, C A Muller and G Westerhout Pp 211–222 (Leiden Astronomical Institutes of the Netherlands, 1954) [1712

New Zealand Meteorological Service Meteorological Office Note No 40 The Drift of Radioactive Dust from the British Nuclear Bomb Tests in October 1953 By J F Gabites Pp 7 (Wellington Meteorological Office 1954) [1712

Pontificia Academia Scientiarum Acta Vol 15 No 1 Sulle Condizioni di Validita della Formula di Green-Stokes Generale Di Giulio Aruffo Pp 14 No 2 Questioni Analitiche Inerenti ai Problemi di Stabilita dell' Equilibrio Elastico Di Luigi Broglio No 3 Notizie sul Gesuita Cristoforo Borri e su sue "Inventioni" da Carte Finora Sconosciute di Poetro della Valle Il Pellegrino Di Angelo Mercati Pp 25–46 No 4 Osservazioni Critiche Circa l'Efficacia Dimostrativa dell' Esperimento di Kennedy Di Mario Galli Pp 47–56 No 5 Il Fisico Tedesco Giorgio Mattia Bose e Benedetto 14 Di Angelo Mercati Pp 57–70 No 6 Ein Vorschlag zur Empirischen Reduktion von Spektralverteilungen Von Joseph Junkes, S J Pp 73–76 No 7 Eduazioni Integrali a Nuclei Sommabili Di Giulo Platone Pp 77–92 No 8 Un Metodo di Interpretazione Analitica di una Batteria di Reattivi Di Marcello Cesa-Bianchi e Angelo Perugia Pp 93–104 No 9 Richerche sul Comportamento degli Interessi nell' età Evolutiva Di Angelo Perugia Pp 105–120 No 10 Proprieta della Strutture Elastoplastiche nello Spazio delle Iperstatiche Di Leo Finzi Pp 121–136 No 11 Dimostrazione Intrinseca del Teorema di Ruemann-Roch Sopra una Curva Di Edoardo Vesentini Pp 137–152 (Città del Vaticano Pontificia Academia Scientiarum, 1951–1953) [1712

PERMUTIT ION EXCHANGE MATERIALS

The use of Permutit Ion Exchange Materials in many roles distinct from water treatment, has resulted in the development of numerous new industrial processes giving improved results and lower running costs Some materials now available are —

Zeo-Karb Na. A sulphonated coal product containing both strong and weak acid groups

Zeo-Karb 215. A nuclear sulphonated phenol resin containing also hydroxyl groups

Zeo-Karb 225 A unifunctional cross linked sulphonated polystyrene resin in bead form of high capacity and exceptional chemical and physical stability

Zeo-Karb 226. A unifunctional cross linked methacrylic acid resin in bead form containing only carboxyl groups as the ion active groups

De-Acidite E. A high capacity anion exchange material of medium basicity.

De-Acidite FF. A unifunctional very highly basic anion exchange resin in bead form based on cross linked polystyrene and containing quaternary ammonium groups

De-Acidite G A unifunctional weakly basic anion exchange resin in bead form based on cross linked polystyrene and containing diethylamino groups

De-Acidite H. A material similar to "De-Acidite G" but containing dimethylamino groups.

Bio-Deminrolit. A mixed cation and anion exchange resin for demineralisation in a single column

Decalso F A synthetic sodium aluminium silicate suitable for the separation and concentration of vitamins and hormones

Decolorite. A resin of high porosity for removing colour from solutions

Permaplex C-10. A highly selective cation exchange resin membrane containing SO_3H groups.

Permaplex A-10. A highly selective anion exchange resin membrane containing quaternary ammonium groups

For full technical information please write to · THE PERMUTIT COMPANY LIMITED Head Office and Laboratories Dept V H 92, Permutit House, Gunnersbury Avenue, London, W 4 Telephone CHIswick 6431

Permutit Ion Exchange Materials — Made in Britain by British Labour

OXOID

DEHYDRATED CULTURE MEDIA

GRANULES—EASY TO HANDLE, LESS HYGROSCOPIC

TABLETS—FOR SIMPLE PREPARATION OF SMALL VOLUMES

Details upon request

Obtainable from Laboratory suppliers or direct from

OXO LIMITED (Medical Dept) THAMES HOUSE, LONDON, E.C.4.

CENtral 9781

LECTURES AND COURSES

BIRKBECK COLLEGE
(UNIVERSITY OF LONDON)
SESSION 1955-1956 BEGINS MONDAY, OCTOBER 3, 1955

Part-time (Evening) Courses provided for Internal Degrees in the Faculties of Arts and Science and for the Academic Postgraduate Diploma in Psychology Facilities also provided for part-time and full-time students reading for higher degrees in arts and science Applications for admission should be made before June 1

Pamphlet and form of application may be obtained from the Registrar, Birkbeck College, Malet Street, W C 1

UNIVERSITY OF LONDON

A lecture entitled "Fact and Fiction in Elementary Dynamics" will be given by Professor T M Cherry (Melbourne) at 5 30 p m on March 14 at University College (Anatomy Theatre), Gower Street, W C 1

Admission free without ticket

JAMES HENDERSON,
Academic Registrar

UNIVERSITY OF LONDON

A course of three lectures on "Paramecium in Modern Biology" will be given by Professor T M Sonneborn (Indiana) at 5 30 p m on March 9, 10 and 11 at University College (Anatomy Theatre), Gower Street, W C 1

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

UNIVERSITY OF LONDON

A course of three lectures on "The Cultural Landscape of Germany, Rural and Urban" will be given by Dr G Pfeifer (Heidelberg) at 5 30 p m. on March 10, 14 and 15 at Queen Mary College, Mile End Road, E 1

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

UNIVERSITY OF LONDON

A course of two lectures on "Curare-Alkaloids" will be given by Professor P Karrer (Zurich) at 5 30 p m on March 10 and 11 at University of London Senate House, W C 1

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

THE MEMBERS OF THE BRITISH PSYCHO-analytical Society invite you to attend the annual Ernest Jones Lecture entitled "The Logic of the Unconscious," which will be given on Monday March 14, at 8 30 p m, in the Barnes Hall of the Royal Society of Medicine (by kind permission of that Society) by John Wisdom, Fellow of Trinity College, Cambridge

---

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE
SHAKESPEARE STREET, NOTTINGHAM
Principal H Baker Ph D, A M I C E, A M I Mech E
FULL-TIME COURSES—SESSION 1955-56

B Sc Special Chemistry (External), University of London and A R I C Vacancies exist in these courses which commence on September 19 1955 Applications for admission should be made on forms obtainable from the Registrar of the College as soon as possible Students who have commenced the course by part-time study may be admitted direct to the second or final year Hostel accommodation is available for male students Suitably qualified students for the above courses may be eligible for financial assistance from their Local Education Authority Ph D (External), M Sc (External), University of London A limited number of vacancies exist for graduates wishing to undertake research work in organic chemistry (heterocyclic chemistry) or physical chemistry (surface chemistry) in preparation for the above degrees Special awards exist for those resident in the East Midland area

Initial inquiries should be made to Mr J R Rowlands, M Sc, A R I C, Head of the Department of Science

F STEPHENSON,
Clerk to the Joint Education Committee

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 to 64 inclusive, or a woman aged 18 to 59 inclusive, unless he or she, or the employment is excepted from the provisions of the Notification of Vacancies Order 1952

WEST LONDON HOSPITAL
HAMMERSMITH ROAD LONDON, W 6
QUALIFIED BIOCHEMIST

Required with considerable experience of clinical biochemical analysis and research Salary scale (principal grade) £1,125 by £50 to £1,375, plus £50 London weighting

Age qualifications, experience, names of two referees to Secretary, Board of Governors The Hammersmith, West London and St Mark's Hospitals, 150 Du Cane Road, London, W 12, by March 14

COMMONWEALTH of AUSTRALIA
APPOINTMENT NO 480/152 OF SENIOR TECHNICAL OFFICER OR PRINCIPAL TECHNICAL OFFICER
COAL RESEARCH SECTION

The Commonwealth Scientific and Industrial Research Organization invites applications for appointment to a position of Senior Technical Officer or Principal Technical Officer at the Coal Research Section, North Ryde, New South Wales Duties Supervision of the collection, preparation, testing and chemical analyses of coal samples in connection with the Section's survey of the physical and chemical properties of Australian coals Qualifications University degree in science or equivalent qualifications, with experience in collection of samples and the complete analysis of coal Salary Dependent of qualifications and experience, commencing salary will be determined within the range of Principal Technical Officer, £A 1,646 to £A 1,814 per annum actual, four increments, subject to efficiency bar at £A 1,730 per annum actual, or Senior Technical Officer, £A 1,310 to £A 1,562 per annum actual, six increments subject to efficiency bar at £A 1,436 per annum actual Fare to Australia (including those of wife and family) will be paid The appointment is subject to a satisfactory medical examination and the appointee may be granted superannuation privileges

Applications, referring to Appointment No 480/152, and stating full name place, date and year of birth, marital state nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by the names and addresses of two persons willing to act as referees, if required and copies of not more than four testimonials, should reach the undersigned not later than April 9, 1955

W IVES,
Chief Scientific Liaison Officer
Australian Scientific Liaison Office,
Africa House, Kingsway London, W C 2

H M OVERSEA CIVIL SERVICE

Applications are invited for the following post Assistant Conservator of Forests, Cyprus Candidates must possess a university degree in forestry and should preferably be under 40 years of age Appointment on contract for two years in the salary scale £734 to £1,094 a year, plus an overseas allowance of 15 per cent of salary Point of entry into the salary scale depends on qualifications and experience A gratuity of £25 or £37 10s (according to salary) is payable for each completed three months of satisfactory service Outfit allowance of £30 Free passages for officer, wife and up to three children on appointment and satisfactory completion of contract Government quarters when available at moderate rental Taxation of salary at local rates

Apply, giving brief particulars to the Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street London, S W 1, quoting reference BCD 61/17/01

AGRICULTURAL RESEARCH COUNCIL require an Assistant Experimental Officer in their Unit of Plant Nutrition, Long Ashton, to assist in investigations on the effects of micro-nutrient elements on the growth of higher plants Qualifications general certificate of education (advanced) or pass degree in botany, or equivalent qualification Some knowledge of chemistry an advantage Salary according to age within scale £288 (at age 18), rising to £640 (men) and to £540 (women) Contributory superannuation scheme —Applications, with names of two referees, to be sent to the Secretary, Research Station, Long Ashton, Bristol, within two weeks

---

UNIVERSITY OF ADELAIDE

Applications are invited for appointment
Senior Lecturer in Electrical Engineering T
appointment is open to candidates with qualifi
tions and experience in any branch of electri
engineering Terms Potential applicants are
vited to seek from the undersigned or from
Secretary of the Association of Universities
the British Commonwealth, 5 Gordon Squa
London W C 1, a copy of the detailed con
tions of appointment Salary scale £A 1,360
£A 60 to £A 1,600 This scale is under revi
but there can be no commitment that the sc
will be advanced Superannuation on F S S
basis Application An application must incl
particulars of age, nationality academic reco
teaching qualifications war service (if any),
present position, a list of publications, co
of testimonials, the names and addresses of
referees of whom inquiries may be made, a
cent photograph, and a medical certificate
good health It should be lodged (in duplic
with the undersigned not later than March
1955

Further information about the post or ab
the University will gladly be supplied on reques

V A EDGELOE
Regist

University of Adelaide,
Adelaide, South Australia

UNIVERSITY OF HONG KON

Applications are invited for the post of Rea
or Senior Lecturer in Applied Mathemat
Emoluments (for a single man on expatriate ter
are as under Readership £1 525 by £50 to £1,
per annum, Senior Lectureship, £1 405 by £40
£1,565 per annum (A family allowance and
variable and temporary high cost of living all
ance are paid as applicable) Applicants m
have appropriate qualifications and experien
First-class sea passages are provided for expatr
staff

Further particulars and information as to
method of application may be obtained from
Secretary, Association of Universities of the Brit
Commonwealth, 5 Gordon Square, Lond
W C 1 The closing date for the receipt of ap
cations, in Hong Kong and London, is April
1955

UNITED KINGDOM ATOMIC ENERGY AUTHORITY
A E R E, HARWELL, BERKS

Invites applications from graduates for posts
the Reactor Studies Group The work cover
a broad field is on studies of advanced types
nuclear reactors for power production and th
development problems Candidates should ha
a first- or second-class honours degree in me
anical or chemical engineering, mathematics
physics In the case of senior posts candida
with mathematics or physics degrees should p
ferably have had some engineering experien
Successful applicants will be appointed accord
to age, experience and qualifications within c
of the following grades Principal Scientific O
cer, £1 205 to £1 615 per annum Senior Sci
tific Officer £1 040 to £1 205 per annum Sci
tific Officer, £505 to £905 per annum, and th
will be required to join the Authority's contri
tory superannuation scheme Rates for wom
are slightly lower

Applications should be sent to Establishm
Officer, United Kingdom Atomic Ener
Authority, A E R E, Harwell, Didcot, Ber
quoting 2/103/248

MINISTRY OF HOUSING AND LOC
Government Chemical Inspector The Civil S
vice Commissioners invite applications for o
pensionable post in London Duties include
vestigation in any part of England and Wa
into water supplies and sewage disposal and t
conduct of public local inquiries into matters ar
ing under the Public Health Acts and the Rive
(Pollution Prevention) Act 1951 Candidat
must have a first- or second-class honours degr
in chemistry or equivalent but a candidate witho
this qualification may if otherwise well-qualifie
be admitted A knowledge of bio-chemistry
biology would be an advantage They must ha
research experience and wide experience in o
(preferably more) of the following the treatme
of water sewage trade effluent river polluti
control or the corrosion of metals by soil a
water Age at least 35 years on January 1, 195
Remuneration (men), for a 45½-hour week, £1 3
to £1 750, starting pay according to age up
£1 576 (at 40), somewhat lower for women —A
plication form and particulars from Civil Servi
Commission Scientific Branch 30 Old Burlingto
Street London, W 1, quoting No S4427/55 A
plications to be returned by March 17, 1955

H M OVERSEA CIVIL SERVICE

Senior Entomologists are required in the Tsetse Control Unit of the Veterinary Department of he Northern Region of Nigeria Duties will be setse survey identification of species, field observations on seasonal distribution and habits of setse flies particularly *Glossina morsitans* and luties in connection with the control of the pecies Candidates should have a natural science legree from a British university, and knowledge f tsetse flies particularly *Glossina morsitans* Appointments can be made as follows (a) On hree years' probation for permanent and pensionable employment with salary, including overseas pay in the scale £1 400 to £1 560 a year ecuring age between 45 and 55 Pension is at he rate of one-six hundredth of final pensionable moluments for each completed month of reckonble service (b) On short-term contract for two ours of eighteen to twenty-four months' duraion in the first instance Consolidated salary in he scale £1 513 to £1 719 a year A gratuity f £37 10s for each completed period of three months' service (including leave) is also payable n satisfactory completion of contract Government quarters are provided at a rental of 10 per ent of basic salary Free passages in both directions are provided for officer and his wife Payment of the cost incurred on one outward and ne homeward passage for each of two children nder the age of 18 subject to a maximum of 75 in respect of the return journey for each hild is also granted Income tax at local rates ocal leave is permissible and generous home eave is granted after each tour of 18-24 months' uration

Application forms can be obtained from the Director of Recruitment, Colonial Office Sancuary Buildings, Great Smith Street London W 1 (quoting reference number BCD 67/408/4)

UNIVERSITY OF CAMBRIDGE

DEPARTMENT OF PHYSICAL CHEMISTRY

A Research Assistant is required in the Research Laboratory on the Physics and Chemistry f Surfaces for work involving the maintenance pplication, and development of an electron microscope and diffraction camera used in the research programme of the laboratory Applicants hould have a good technical qualification or scientific training and preferably some experience f vacuum technique or electronics The position is unestablished and the salary will be about £400 er annum

Applicants should submit a brief account of heir experience and qualifications mentioning ge to the Secretary P C S Laboratory Department of Physical Chemistry, Free School Lane Cambridge

ROTHAMSTED EXPERIMENTAL STATION

HARPENDEN HERTS

Applications are invited for a post in the hysics Department from graduates with a good onours degree, some research experience and an nterest in the application of physics to soil o lant science The appointment will be in the rade of Scientific Officer (£467 to £750 (women) to £845 (men)) Starting pay according to experience period of National Service and age uperannuation F S S U Further information n request

Applications quoting 108 with full particulars nd names and addresses of two referees should each the Secretary by March 31 1955

GOVERNMENT OF TANGANYIKA

A vacancy exists for a Computer (male or female), Lands and Survey Department, Tanganyika (Rice Investigation Scheme) Qualifications Degree in mathematics, physics or engineering, preferably the first named Age limit under 40 years Duties Computation of surveys of a geodetic astronomical or cadastral nature and the keeping of records Terms of appointment On contract for one tour of 30 to 5 months with salary in the scale £588 to £1 320 lus inducement pay of between £174 to £300 per annum plus cost-of-living allowance of 10 per cent of substantive salary subject to maximum f £162 per annum Gratuity at the rate of 1½ per cent of salary and inducement pay is also payable on satisfactory completion of contract Outfit allowance £45 free passages Leave at rate of five days for each completed month of resident service Income tax at low local rates

Apply in writing to the Director of Recruitment Colonial Office Great Smith Street London S W 1, giving briefly age qualifications and xperience Mention the reference number BCD 07/8/06

PLANT BREEDING INSTITUTE

CAMBRIDGE

Applications are invited for the post of Scientific Officer in the Forage Crops Section to engage in genetical, physiological and breeding research in grasses and legumes Good honours degree in science essential Starting salary within range of £467 10s to £845 per annum with F S S U benefits

Applications, with names of three referees, to be sent to the Secretary Plant Breeding Institute Trumpington, Cambridge, before March 16

GOLD COAST LOCAL CIVIL SERVICE

A vacancy exists for a Government Chemist Public Works Department Gold Coast Local Civil Service Qualifications Honours degree in chemistry and Associateship or Fellowship of Royal Institute of Chemistry preferably in Branch I Sound knowledge of bacteriology and biology of water supply required Experience of practical operation of water purification plant essential Duties Supervision of purification of Government water supplies and investigation of new supplies Terms of Appointment On contract terms for two tours of duty (18 to 24 months each tour) with consolidated salary according to experience in the scale £1 030 to £2 020 per annum plus gratuity of £37 10s for each completed three months resident service payable on satisfactory termination of contract Outfit allowance between £30 to £60 per annum according to commencing salary Free first-class passages, quarters when available, at rental of between £60 to £90 per annum Vacation leave at rate of seven days for each completed month of resident service Income tax at low local rates

Apply in writing to the Director of Recruitment Colonial Office Great Smith Street London S W 1 giving briefly age qualifications and experience Mention the reference number BCD 112/13/018

UNIVERSITY OF NOTTINGHAM

Applications are invited for the appointment of Assistant Lecturer in Geology Salary within the scale £550 by £50 to £650, according to qualifications and experience Membership of Federated Superannuation System for Universities and family allowances

Conditions of appointment and form of application from the undersigned

H PICKBOURNE
Registrar

MINISTRY OF SUPPLY REQUIRE SCIENtific Officers for research and development on targets for guided weapons at Royal Aircraft Establishment, Farnborough, Hants Post 1 primarily concerned with performance assessment experience in aerodynamics useful Post 2 concerned with automatic control problems, knowledge of servomechanism theory an advantage Qualifications first- or second-class honours degree or equivalent in mathematics or mathematical physics Salary within range £467 10s to £845 Women somewhat less Prospects of promotion to higher grades Not established but opportunities to compete for establishment may arise F S S U benefits may be available —Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street London S W 1 quoting A 36/5A Closing date March 19 1955

VICTORIAN GOVERNMENT RAILWAYS offer careers in Australia to (a) Engineer (communications) starting as Engineer Class 2 with salary range from £A 1 373 to £A 1 443 subject to quarterly adjustments in accordance with cost of living Higher salaries on promotion Candidates must hold a university degree or technical college diploma or equivalent in electrical engineering or communications engineering (b) Assistant Engineer (signalling) starting as Assistant Engineer Class 3 with salary ranging from £A 958 (minimum Class 3) to £A 1 138 (maximum Class 2) subject to quarterly adjustments in accordance with cost of living Commencing salary according to qualifications and experience Higher salaries on promotion Candidates must hold technical college diploma or equivalent in electrical engineering Special housing and travelling facilities Generous leave and superannuation benefits —Apply in writing to Agent-General for Victoria Victoria House Melbourne Place Strand London W C 2 giving briefly age marital status, qualifications and experience Please endorse envelope "Victorian Railways"

COMMONWEALTH of AUSTRALIA

APPOINTMENT NO 290/395 OF RESEARCH OFFICER—CHEMIST

DIVISION OF FOREST PRODUCTS

The Commonwealth Scientific and Industrial Research Organization invites applications for appointment to a position of Research Officer, Division of Forest Products, S Melbourne Duties To carry out fundamental and applied research in various chemical aspects of wood preservation against fungi, termites borers and marine organisms, etc Qualifications University honours degree or higher qualifications with chemistry as a major subject Salary Dependent on qualifications and experience, commencing salary will be determined within the range of Research Officer, £A 1 184 to £A 1 730 per annum actual, thirteen increments subject to efficiency review at £A 1 268 and £A 1 520 per annum actual Fare to Australia (including those of wife and family) will be paid The appointment is subject to a satisfactory medical examination and the appointee may be granted superannuation privileges

Applications referring to Appointment No 290/395 and stating full name place date and year of birth marital state nationality present employment particulars of qualifications and experience and of war service if any accompanied by the names and addresses of at least two persons willing to act as referees, if required and copies of not more than four testimonials, should reach the undersigned not later than April 2 1955

W IVES,
Chief Scientific Liaison Officer

Australian Scientific Liaison Office,
Africa House,
Kingsway London W C 2

McMASTER UNIVERSITY

DEPARTMENT OF PHYSICS

GRADUATE ASSISTANTSHIPS

Applications are invited for part time teaching and research assistantships in the Department of Physics McMaster University from persons qualified to register in courses leading to the M Sc and Ph D degrees Assistantships normally carry a yearly stipend of $1 450 to $1 850 Assistants are required to devote 10 to 12 hours per week to duties during the academic session (October to April inclusive) and are able to devote full-time to their research during the summer Research is in progress in the following fields Theory of Molecular Spectra F R Britton, Atomic Mass Determinations H E Duckworth Cosmic Rays F Gulbis Beta and Gamma Spectroscopy M W Johns Microwave Diffraction A B McLay, Solid State, H E Petch, Theoretical Nuclear Physics M A Preston Fission Yields and Isotopic Abundances H G Thode

Interested persons should write to Dr H E Duckworth Department of Physics Hamilton College McMaster University Hamilton Ontario, Canada

UNIVERSITY OF SHEFFIELD

Applications are invited for the newly established Chair of Applied Mathematics to be filled as soon as possible The term Applied Mathematics" is to be interpreted in a wide sense—e g a candidate whose field is theoretical physics or astrophysics or meteorology would be acceptable Salary £2 150 with F S S U provision and family allowance

Further particulars should be obtained from the Registrar The University Sheffield 10 to whom applications should be sent by April 2 1955

UNIVERSITY OF LONDON

Applications are invited for I C I Research Fellowships in Biochemistry Chemistry Chemotherapy Engineering Metallurgy Pharmacology Physics or allied subjects tenable from October 1, 1955 normally for three years in the first instance Salary not less than £750 per annum, with family allowances and F S S U

Information and application forms can be obtained from the Academic Registrar University of London Senate House W C 1 Applications must be received not later than April 16 1955

ST BARTHOLOMEW'S HOSPITAL

LONDON E C 1

Applications are invited for the post of Chemical Pathologist to the Hospital and Lecturer in Chemical Pathology to the Medical College tenable as from July 1 1955 The successful candidate will be on a full-time salary basis part of which will be paid by the hospital and part by the medical college The appointment will be subject to a satisfactory health report

Applications together with the names of three referees should be received not later than April 1 1955 and should be addressed to C C Carus Wilson Clerk to the Governors

GAS COUNCIL

SCIENTIFIC SECRETARY

Applications are invited for the appointment of Scientific Secretary to the Gas Council at a salary of the order of £2 500 per annum The successful applicant will be expected generally to advise on scientific matters and particularly to act on behalf of the Research Committee of the Gas Council in maintaining liaison between that committee, the Directors in charge of the Council's Research Stations, the various research associations and other organizations conducting research with which the Gas Council may be associated The successful candidate must have had considerable experience in the direction of research and should be able to show a proper appreciation of the relationship between research and commercial development - While the directors in charge of research stations will maintain their full responsibilities to the Gas Council for the conduct of their stations, the Scientific Secretary must be fully qualified to discuss with them the various lines of investigation in hand or projected The appointment will be pensionable, unless the successful applicant is over 55 years of age on appointment

Applications, giving full particulars of academic qualifications and appointments held, should be sent to reach the Secretary, The Gas Council 1 Grosvenor Place, London, S W 1, not later than April 16, 1955

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Assistant Lecturer or Lecturer in the Department of Zoology The initial salary for an Assistant Lecturer will be £550 per annum The initial salary for a Lecturer will be within the range £650 to £800 per annum, according to qualifications and experience

Applications, stating age, experience and academic qualifications together with the names of three referees, should be received not later than April 2, 1955 by the undersigned, from whom further particulars of the conditions of appointment may be obtained

STANLEY DUMBELL,
Registrar

UNIVERSITY COLLEGE OF THE WEST INDIES

Applications are invited for the Chair of Zoology Salary £1,800 per annum Child allowance £80 per annum per child (maximum £240 per annum) F S S U Passages paid on appointment, termination and study leave Unfurnished accommodation at rental of 5 per cent of basic salary Duties to be assumed by October 1, 1955

Applications (eight copies) detailing qualifications and experience and naming three referees, to be received by March 21, 1955, by Secretary Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W C 1, from whom further particulars may be obtained

---

UNIVERSITY OF LEEDS

Applications are invited for Imperial Chemical Industries Limited Research Fellowships in Bacteriology, Biochemistry Biomolecular Structure, Botany (Plant Biochemistry and Biophysics), Chemical Engineering, Chemistry, Chemistry of Leather Manufacture Chemotherapy Colour Chemistry and Dyeing Engineering (Civil, Electrical or Mechanical) Fuel and Refractories Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying), Pharmacology Physics, Physiology or Textile Industries (Protein Chemistry and Wool Textile Engineering) The Fellowships will be of an annual value within the range £600 to £900 a year according to qualifications and experience and will normally be tenable for three years

Further particulars can be obtained on request Three copies of applications (one in the case of applicants from overseas), together with the names of two referees should reach the Registrar, The University, Leeds, 2, not later than April 15, 1955

UNIVERSITY OF MANCHESTER

Applications are invited for the posts of Lecturer in Astronomy and two Lecturers in Radio-Astronomy Salary on a scale £500 to £1,100 per annum, initial salary according to qualifications and experience (Salary scales are at present under review) Membership of F S S U and children s allowance scheme

Applications should be sent not later than March 26, 1955, to the Registrar, The University, Manchester, 13, from whom further particulars and forms of application may be obtained

---

H M OVERSEA CIVIL SERVICE

Vacancies exist for Chemists in the Department of Chemistry, Federation of Malaya Qualifications Honours degree in chemistry with Associateship or Fellowship of Royal Institute of Chemistry Two years' specialized experience in some line (forensic science, toxicology, foods, drugs and water, bacteriology, pharmacy, etc), relevant to the work in Malaya, or research experience indicated by Ph D or comparable post-graduate qualification For pensionable employment age limit 25-30 For contract appointments age limit may be exceeded Duties General analytical and consultative work on liquors, foods, drugs, water and petroleum etc Clinical analysis and examination of exhibits for court evidence Inspection of petroleum carrying vessels and explosives To make reports, give evidence in court, and assist in the training of subordinate staff Terms of appointment (a) Pensionable with salary and pensionable overseas allowance from £1,004 to £2,072 per annum (incremental credits may be granted for experience) An additional non-pensionable overseas allowance for a married officer A substantial non-pensionable cost-of-living allowance, according to family commitment is also payable to all officers At present total emoluments for a single man range from £1,218 per annum to £2,100, for a married man without children from £1,442 per annum to £2,499 per annum, and for a married man with dependent children from £1,533 per annum to £2,730 per annum (b) On contract for three years (with provision for renewal) in above salary scale and with same allowances Gratuity is payable at rate of £70 for each completed period of three months' satisfactory service on full pay provided officer's basic salary is £1,277 per annum, or above For basic salaries below £1,277 per annum gratuity is payable at the rate of £50

Apply, in writing, to the Director of Recruitment, Colonial Office, Great Smith Street, London, S W 1, giving briefly age, qualifications and experience Mention the reference number (BCD /97/60/01)

EAST AFRICA HIGH COMMISSION

FISHERIES OFFICER

Vacancy for a Fisheries Officer, Lake Victoria Fisheries Service, East Africa High Commission Duties include the development and control of the fisheries of Lake Victoria Qualifications Candidates must possess a university degree in natural science, preferably zoology, and be under 35 years of age Terms of Appointment Pensionable after a probationary period of two years Emoluments Salary scale £816 to £1,620 a year Point of entry into the salary scale depends on qualifications and experience Variable non-pensionable cost of living allowance, at present at the rate of 10 per cent of salary Outfit allowance £30 if initial salary below £1,032 a year Government quarters when available at rental of not more than £102 a year Free passages for officer, wife and up to one full fare for children on first appointment and leave Taxation at local rates

Apply, giving brief particulars to the Director of Recruitment, Colonial Office, Sanctuary Buildings Great Smith Street, London, S W 1, quoting reference BCD 65/88/01

UNIVERSITY OF LEEDS

DEPARTMENT OF MINING

The Council invites applications for two Research Assistantships in the Department of Mining at salaries up to £500 a year according to qualifications and experience Candidates should hold a good honours degree in physics or physical chemistry

Applications (three copies), stating date of birth qualifications and experience together with the names of three referees, should reach the Registrar The University, Leeds, 2 (from whom further particulars may be obtained) not later than March 18, 1955

ROWETT RESEARCH INSTITUTE

Assistant Experimental Officer required for biochemical work on certain rumen micro-organisms Candidates should be graduates or hold a higher national certificate in chemistry or its equivalent Some experience in bacteriology would be desirable Salary scale (men) £288 10s (aged 18) to £640 per annum, (women) £288 10s (age 18) to £540 per annum

Applications stating date of birth, with particulars of education and experience, together with the names of two referees, should be sent to the Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire

---

TROPICAL RESEARCH FELLOWSHIP

(MEDICAL SCIENCES)

Applications are invited by the Council of th Royal Society for a Research Fellowship wit special reference to ill health in the tropics Th Fellowship is tenable in any university, hospit or medical school or other institution approved b the Royal Society in the British Commonwealth The successful applicant, who need not necessaril hold a medical qualification, will be expected t spend some part of the period of tenure in th tropics The appointment will be for two yea in the first instance, from October 1, 1955, an may be renewed annually up to a total of fiv years It will be subject to the conditions govern ing Royal Society Research Appointments Th stipend will be £1,250 per annum

Applications, which should be made on form to be obtained from the Assistant Secretary, Th Royal Society, Burlington House, London, W 1 should be received as early as possible, in an case not later than May 31, 1955

GOLD COAST LOCAL CIVIL SERVICE

SENIOR SOIL CONSERVATION OFFICER
DEPARTMENT OF AGRICULTURE

Duties comprise the planning, administratio and execution of schemes for soil conservatio and land utilization, and the tendering of advic on problems of soil conservation Candidat must possess a university degree in an appropriat subject and have had at least one years' pos graduate study or experience of soil conservatio Appointment on contract in the salary scal £1,530 to £1,950 a year with a gratuity of £25 t £37 10s for each completed three months of sati factory service Outfit allowance of £30 payabl on first appointment Free first-class passages o appointment and leave for officer, wife and up t three children under thirteen years of age Gene ous home leave Taxation at local rates

Apply, giving brief particulars, to the Directo of Recruitment, Colonial Office, 2 Sanctuar Buildings, Great Smith Street, London, S W 1 quoting reference BCD 63/13/017

DEPARTMENT OF AGRICULTUR

WESTERN REGION, NIGERIA
SOIL SURVEY OFFICER

To take part in the field work of a scheme o systematic classification and mapping of soil Candidates must possess a university degree eithe in geography or in science with geology or geography as one subject Some knowledge of chemistry and an interest in botany and plant geography desirable Appointment on contract i the salary scale £627 to £1,287 a year, plus a allowance of £180 to £270 a year A gratuity c £25 to £37 10s is payable for each three month of satisfactory service Outfit allowance of £6 Free first-class passages on appointment and leav for officer, wife and two children under 18 yea of age Generous home leave Taxation at loc rates Government quarters when available rental of 10 per cent of basic salary

Apply, giving brief particulars to the Directc of Recruitment, Colonial Office, Sanctuary Buil ings Great Smith Street, London, S W 1, quotin reference BCD 63/410/02

COVENTRY AND WARWICKSHIR HOSPITAL

Technician required for Physics Workshop radiotherapy, isotope, research and routine work General machine shop experience essential, knowledge of electronics desirable Salary £450 t £515 per annum

Applications to Secretary, Hospital Manageme Committee, Coventry and Warwickshire Hospita Coventry

---

REGIONAL PHYSICS DEPARTMENT, 9-1 West Graham Street, Glasgow, C 4, Deput Regional Physicist It is intended shortly to ap point an additional Physicist, for duties in th Regional Physics Department, which provides variety of technical services to hospitals and medical research institutions throughout the West c Scotland Applications are now invited fro candidates possessing a wide and thorough knowledge of classical and modern physics with recen experience of a responsible kind in a large de partment devoted to the practice of clinica physics Salary will be according to the Whitle Council scale (£1,125 by £50 to £1,375) and appli cations including the names of two referees should be sent before March 26, 1955, to the Secretary and Treasurer, Board of Management fo Glasgow Western Hospitals, 10 Park Circus Glasgow, C 3

QUEEN'S UNIVERSITY OF BELFAST

Applications are invited for a Research Fellow-ip in the Department of Chemistry for work heterogeneous catalysis In addition to carry- out independent work the Fellow appointed ll be expected to assist in directing the research others working on catalytic problems The pointment will be for one year from October 1 55, and may be extended Salary £700 plus S S U benefits, or £750 without F S S U nefits

Letters of application with particulars of aca-mic qualifications and the names and addresses two referees should reach Professor C emball by April 30, 1955

UNIVERSITY OF CAMBRIDGE

SHELL RESEARCH STUDENTSHIP IN CHEMICAL ENGINEERING

The Managers of the Shell Chemical Engineer- Studies Fund invite applications for a Shell search Studentship Applicants should in neral have already received a first research de-e or at least have shown considerable promise research The successful candidate will be re-ired to engage in research in chemical engineer- under such conditions as the Managers may termine The studentship will be of £600 a ar, plus fees for two years, with the possibility an extension for a further year The success- applicant would be expected to commence ndence in October, 1955

Application forms may be obtained from the ell Professor of Chemical Engineering Depart-nt of Chemical Engineering, Tennis Court oad, Cambridge and should be completed and turned by April 23 1955

ELECTRICAL ENGINEERS REQUIRED FOR rious Research and Development Establishments Ministry of Supply at Farnborough Hants, alvern, Worcs Sevenoaks Kent, Christchurch, ants, and London H Q Applicants should have be expecting to obtain a first- or second-class nours degree or equivalent preferably with ex-rience in light electrical or electronic engineering lds Initial appointment to Scientific Officer ade Salary according to age, experience etc, thin range £467 10s to £845 (£25 to £40 higher London) Women somewhat less Prospects promotion Not established but opportunities compete for establishment may arise F S S U nefits may be available—Application forms om Ministry of Labour and National Service, chnical and Scientific Register (K) 26 King eet London S W 1, quoting D 63/5A

UNITED KINGDOM ATOMIC ENERGY thority, A E R E, Harwell Berks, requires a emist or Biologist for its Health Physics Divi-n to undertake work on the uptake and tabolism of radioactive elements in biological terials He may be required to lead a group gaged in experimental field work Applicants ould possess at least a second-class honours de-e in either chemistry or biology A good owledge of chemical analysis will be essential e successful candidate will be appointed either a Senior Scientific Officer (£1 040 to £1,205 per num) or as a Scientific Officer (£505 to £905 r annum) according to age, experience and alifications and will be required to join the thority's contributory superannuation scheme post as a Principal Scientific Officer (£1,205 to 615 per annum), might be granted to an ex-tionally well-qualified applicant—Applications ould be sent to Establishments Officer United ngdom Atomic Energy Authority A E R.E, rwell Didcot Berks quoting 2/103/237

NATIONAL COAL BOARD INVITE APPLI-ions for a superannuable appointment as entist Grade III in their Coal Survey Labora-y at Cardiff The work includes the prepara-n of detailed reports on the structure and ysical and chemical properties of coal seams of South Wales Bristol and Somerset, and Forest Dean coalfields A good honours degree (or uivalent qualification) in a science subject ferably with a sound background in geology d chemistry is required Appointment will ially be as Scientist Grade III (scale £500 by 5 to £950 male and £475 by £20 to £835 male) Promotion to Scientist Grade II (scale 00 by £35 to £1,150 male, and £700 by £30 to 000 female), is open after a period dependent experience and ability—Write giving full par-ulars (in chronological order) of age, education alifications and experience (with dates), to tional Coal Board, Establishments (Personnel), bart House Grosvenor Place London, S W 1, rking envelope TT/932 Original testimonials ould not be forwarded Closing date March 1955

COUNTY BOROUGH OF GRIMSBY EDUCATION COMMITTEE

COLLEGE OF FURTHER EDUCATION

Principal E S Green, B Sc A R I C

Applications are invited from suitably qualified persons for the following post Assistant to teach Chemistry up to final degree standard A new college is in course of erection and it is expected that there will be considerable expansion of the Science Department Applicants should possess an hons degree in chemistry, or equivalent qualification teaching and/or industrial experience are desirable Salary in accordance with the Burnham Technical Report for a Grade B Assistant (£525 by £25 to £820) plus where appropriate the usual additions for degree and training

Application forms may be obtained from the undersigned (S A E) to whom completed applications should be returned not later than 14 days after the appearance of this advertisement Canvassing disqualifies

R E RICHARDSON
Director of Education

Education Office
Eleanor Street
Grimsby

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

SENIOR LECTURER IN PAPER-MAKING TECHNOLOGY

The Governing Body invites applications for an appointment as Senior Lecturer in Paper-Making Technology with similar title and status in the University Candidates should be graduates in science or technology who have had extensive research experience with fibres The successful applicant will be expected to devote himself to research lecturing and the organization of the paper-making section of the Textile Chemistry Department He will be under the general supervision of the Head of the Department of Textile Chemistry The paper-making section is housed in new laboratories in the extension of the College Salary scale £1 400 to £1 750 by annual increments of £50 The starting salary may be anywhere within this scale depending on the qualifications and experience of the applicant Superannuation under the F S S U and family allowances

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology Manchester 1 The last day for receipt of application is March 31, 1955

B V BOWDEN
Principal of the College

MINISTRY OF SUPPLY REQUIRE PHYSICAL Chemist and/or Physicists for following posts at Royal Aircraft Establishment, Farnborough Hants (1) Physicist with good background in mathematics to work on properties of materials with particular reference to aircraft. Candidates should have an interest in physical and mechanical testing in development of suitable test methods and in properties of materials generally (2) Physicist or Physical Chemist with an interest in properties of materials for work on development of fibre in reinforced products with particular reference to use in aircraft A knowledge of plastics industry would be an asset Qualifications higher school certificate (science) or equivalent Some interest in engineering may be an advantage Appointments as Assistant Experimental Officer with salary range £288 10s (age 18) to £640 Women somewhat less Possibilities of promotion to higher grades Not established but opportunities to compete for establishment may arise—Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street London S W 1 quoting A51/5A Closing date March 29, 1955

CHEMICAL ENGINEER REQUIRED BY THE National Research Development Corporation to join a team engaged in research connected with the design and development of multimembrane electrodialysis cells and to supervise the construction of semi-technical scale demonstration plant Applicants should be between 24 and 30 years of age and should hold a degree in chemical engineering or physical chemistry with at least two years' postgraduate experience The appointment is tenable at the Low Temperature Research Station, Cambridge and is for two years in the first instance Initial salary £700 to £900 according to experience The conditions are similar to those attaching to Research Fellowships—Application giving full details of qualifications should be made to the Superintendent, Low Temperature Research Station Downing Street, Cambridge

---

YORKSHIRE OUSE RIVER BOARD

Applications are invited for the appointment of Biologist in the Chief Inspector s Department at a salary in accordance with Grade III of the National scales (£600 to £725 per annum) Candidates should possess a degree in biology with chemistry as a subsidiary subject and have had previous experience in freshwater biology The appointment will be subject to the Local Government Superannuation Acts and the National Joint Council's Scheme of Conditions of Service and will be terminable by one month s notice on either side

Applications, stating age, qualifications and previous experience and accompanied by copies of not more than two recent testimonials should be sent to the Chief Inspector Yorkshire Ouse River Board, 21 Park Square South, Leeds 1, within fourteen days of the appearance of this advertisement Canvassing, either directly or indirectly will disqualify

A W WOOD
Clerk and Solicitor of the Board

21 Park Square South
Leeds 1

UNIVERSITY OF LEEDS

DEPARTMENT OF MINING

The Council invites applications for two Lectureships in the Department of Mining one in Dressing of Minerals and the other in Surveying the salary scale is at present under review Candidates for the Lectureship in Dressing of Minerals should be experienced in the design and operation of different types of plant and for the Lectureship in Surveying in topographical surveys

Applications (three copies) stating date of birth qualifications and experience, together with the names of three referees should reach the Registrar The University Leeds 2 (from whom further particulars may be obtained) not later than March 18 1955

UNIVERSITY OF SOUTHAMPTON

Applications are invited for the post of Research Assistant in Ecology (second appointment) established under Nature Conservancy grant for investigations into competition between fen dominants in the Norfolk Broads Requirements include a first- or good second-class degree in botany with ecological and physiological interests The appointment is for three years and work for a higher degree is permitted Salary £375 per annum plus £75 per annum travelling allowance

Further particulars from the Secretary and Registrar, University of Southampton Closing date March 26 1955

UNIVERSITY OF MANCHESTER

Applications are invited for an Assistant Lecturer in Botany Candidates should have special interests in mycology Salary on a scale £450 to £550 per annum with membership of F S S U and children s allowance scheme (salary scales at present under review)

Forms of application and further particulars may be obtained from the Registrar The University, Manchester 13 to whom applications should be sent as soon as possible but not later than March 16 1955

BATTERSEA POLYTECHNIC

LONDON S W 11

Applications are invited from honours graduates of a British university for the post of Grade B Lecturer in Physics Salary £621 or £633 by £25 to £928, plus allowance of £30 for a good honours degree a training allowance and increments for industrial or research experience

Further particulars from the Clerk to the Governing Body by whom application should be received as soon as possible

---

BRITISH TRANSPORT COMMISSION RESEARCH Department (Railways), a vacancy exists at Derby for a Scientific Officer Grade I, salary range £850 to £950 Candidates must possess a good degree in physics The post offers a wide scope in problems involving classical physics, and applicants should indicate in which direction their particular interest lies Superannuation and certain free travel facilities—Applications to Director of Research (Railways) Staff Section, 222 Marylebone Road London N W 1

UNIVERSITY OF LONDON, KING'S COLLEGE will require on October 1 1955, two Lecturers in Physiology one to replace a member of staff recently appointed to a chair The salary will be at a point on the scale £900 by £100 to £1 200 with family allowances and F S S U benefits—Particulars and application forms should be obtained from the Registrar King s College Strand, W C 2 whom completed applications should reach by March 28, 1955

MEDICAL RESEARCH COUNCIL

Applications are invited for the post of Research Assistant in the Climatic and Working Efficiency Unit of the Medical Research Council at the Department of Human Anatomy in the University of Oxford, to take part in fundamental studies of muscle and joint action and the application of this to clinical, industrial and service problems Candidates should have a medical degree or an honours degree in physiology or zoology The salary will be dependent on qualifications and experience Superannuation provision will be made under the Federated Superannuation System for Universities

Applications, giving age, qualifications, experience, list of published work and copies of testimonials, should reach Professor Sir Wilfrid Le Gros Clark, F R S, Department of Human Anatomy, University Museum, Oxford, not later than April 30, 1955

UNIVERSITY OF READING

DEPARTMENT OF AGRICULTURAL BOTANY

Applications for the post of Assistant Lecturer in Agricultural Botany are invited from honours graduates in botany or agricultural botany, and from those who expect to obtain such a degree this summer The appointment will be for three years The salary will be within the range from £550 per annum to £650 per annum, F S S U and child allowance

Further particulars may be obtained from The Registrar, by whom applications should be received not later than April 30, 1955

LIVERPOOL RADIUM INSTITUTE MANAGEMENT COMMITTEE

1 MYRTLE STREET, LIVERPOOL, 7

Applications are invited for the post of Hospital Physicist, Senior Grade, first- or second-class honours degree essential Whitley Council scales and conditions of service

Applications, giving qualifications and experience, together with names and addresses of two referees, should reach the undersigned not later than March 15, 1955

D BRYSON,
Secretary to the Committee

UNIVERSITY OF SHEFFIELD

Applications are invited for a post of Research Assistant to the Professor of Mining, to begin duties as soon as possible Salary up to £750, with F S S U provision and family allowance Applicants should have a good degree in mining, engineering or pure science

Further particulars should be obtained from the Registrar, to whom applications (four copies) should be sent by March 26, 1955

BRITISH ELECTRICITY AUTHORITY, Yorkshire Division, require an Assistant Chemist in the Fuel Section of the Divisional Chemical Laboratory, sited at Skelton Grange Power Station, Leeds Salary will be within the range £600 to £725 per annum, Grade 6 Class AX N J B Agreement Schedule C, according to qualifications and experience and will rise ultimately to a maximum of £805 per annum Applicants should hold higher national certificate in chemistry or its equivalent and have had previous experience associated with the sampling and analysis of fuel and related work —Application forms, obtainable from Divisional Secretary (Establishments) British Electricity House, St Mary's Road, Leeds 7, to be returned within fourteen days of the appearance of this advertisement

G A VOWLES,
Divisional Controller

AERODYNAMICISTS AND AERONAUTICAL Engineers required at Research and Development Establishments of Ministry of Supply at Amesbury, Wilts, Farnborough, Hants and London H Q Research or experimental experience of aircraft problems desirable Prospects of promotion Not established but opportunities to compete for establishment may arise Qualifications, Scientific Officer Class, first- or second-class honours degree or equivalent Experimental Officer Class, higher school certificate (science) or equivalent, but higher national certificate, G R Ae S, pass degree, etc, may be an advantage Appointments and salary according to age, research experience, etc, as Scientific Officer, within range £467 10s to £845, Experimental Officer (minimum age 26), £715 to £880, Assistant Experimental Officer £288 10s (age 18) to £640 (London rates £14 to £40 higher) Women somewhat less F S S U benefits may be available for Scientific Officer grade —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K) 26 King Street, London, S W 1 quoting C 84/5A

COMMONWEALTH of AUSTRALIA

AUSTRALIAN ATOMIC ENERGY COMMISSION

APPLIED MATHEMATICIAN OR MATHEMATICAL PHYSICIST

Applications are invited for two such positions (a) Research Officer in the salary range £A 1,184 to £A 1,730, to carry out theoretical calculations in connection with nuclear reactor design, and (b) Principal Research Officer in the salary range £A 2,228 to £A 2 588 (or for an exceptional applicant, Senior Principal Research Officer in the range £A 2,678 to £A 3,000) to originate theoretical work in the field of nuclear reactor design Appointees will be required to work outside Australia initially Details of the terms and conditions of appointment, allowances, superannuation and the general structure and scope of the Commission are available from the undersigned or from the Commission's Liaison Officer, Australia House, Strand, London, W C 2

Applications, with relevant personal particulars, qualifications, war service and names of referees, should be sent by May 2, 1955, to The Secretary, Australian Atomic Energy Commission, 45 Beach Street Coogee, New South Wales, Australia

---

UNIVERSITY OF ALBERTA

FACULTY OF AGRICULTURE

Applications are invited for the position of Assistant Professor of Soil Science, duties to commence on September 1, 1955 Initial salary $4,000 to $5,000, depending on qualifications and experience There is a cost-of-living bonus of about $300, and the normal yearly increment is $250 Preference will be given to a university graduate, with a Ph D degree or equivalent training, who has specialized in soil science Duties will include research, teaching, soil testing, and extension work in soil science Confirmation of the appointment will be subject to the satisfactory completion of a probationary period of two to four years

Applications should be addressed to the Head of the Department of Soil Science, Faculty of Agriculture University of Alberta, Edmonton, Alberta and should give details of training and experience, personal information, the names of three referees, and be accompanied by a recent photograph Closing date May 1 1955

ROTHAMSTED EXPERIMENTAL STATION

HARPENDEN, HERTS

Assistant Experimental Officer (male) required in the Botany Department, to help in field work on the physiological analysis of growth and yield of agricultural crops, and in related laboratory work Applicants should be graduates in botany or agricultural botany, with training in plant physiology and preferably some knowledge of modern methods of field experimentation Commencing salary, according to age, up to £512 per annum at age 26 Superannuation scheme

Applications, quoting reference 102, with names of two referees, should reach the Secretary by March 21, 1955

BRITISH EMPIRE CANCER CAMPAIGN invites applications from suitably qualified British subjects for Exchange Fellowships in cancer research during 1955-56 Fellowships are of one year's tenure in North America at a stipend of $4,000 per annum, which will be paid by the National Cancer Institute of Canada to Fellows proceeding to Canada, and by the American Cancer Society to Fellows proceeding to the United States Travelling expenses to and from centre of work will be borne by the Campaign The closing date for the receipt of applications is March 31, 1955 —For further particulars and application forms apply to the Secretary General, British Empire Cancer Campaign, 11 Grosvenor Crescent Hyde Park Corner, London S W 1

A VACANCY EXISTS FOR A PHYSICIST with a minimum of two years' hospital experience for work in the Radiotherapy Departments of St Bartholomew's Hospital and the North Middlesex Hospital, Edmonton Salary scale £585 by £30 to £765, plus London weighting, starting salary will be based on previous experience —Write in the first instance by March 11, 1955, enclosing two copies of testimonials to C C Carus-Wilson, Clerk to the Governors St Bartholomew's Hospital London, E C 1, marking envelope "Physicist"

BIOCHEMISTRY GRADUATE, PREFERably with some research experience, required for investigations on red-cell enzymes Salary up to £700 per annum, according to qualifications —Applications by April 15, 1955 Further details from the Regional Director Blood Transfusion Service, Royal Infirmary, Edinburgh, 3

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

Graduate is required by the Fuel Technolo Section of the Physics Department of the abo Association to undertake research of a varied a interesting nature, and which in the first insta will be mainly in connection with problems heating and cooling of steel The post will centred at London but will entail operatio studies at steel works Candidates should have degree in technology, science or engineering a preferably some experience of problems of steady heat flow Starting salary up to £775 annum, according to age, qualifications and perience Post is superannuated under F S S U

Written applications only, quoting "Fuel Te nology," to Personnel Officer, B I S R A, Park Lane, London, W 1

FOOT-AND-MOUTH DISEASE RESEARCH INSTITUTE

Applications are invited for a post of Resea Assistant (female) Duties are concerned w research on serology of viruses Qualificatio should preferably include B Sc (bacteriolog The post is superannuable and salary in acco ance with nationally agreed scales related to a qualifications and experience These are Assist Experimental Officer grade (£372 at age 21, risi by eight increments to £540) or Scientific Offi grade (£467 by ten increments to £750)

Applications, stating age, qualifications, deta of past and present appointments and acco panied by the names of three referees, should addressed to the undersigned immediately

N SMITH,
Secreta

Pirbright, Surrey

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

Physicist required, for work in the Flu Dynamics Section of the Physics Department the Association's Laboratories in London Ca didates should have a degree in physics, with p ferably some industrial or research experienc Work will be mainly on the treatment of gas and aerosols Starting salary up to £750 p annum, according to age, qualifications and e perience Post is superannuated under t F S S U

Written applications only quoting "Flu Dynamics," to the Personnel Officer, B I S R 11 Park Lane, London, W 1

ROTHAMSTED EXPERIMENTAL STATION

HARPENDEN, HERTS

Applications are invited for the post of He of the Department of Entomology The a pointment will be in the Senior Principal Scie tific Officer grade (£1,600 by £75(3) by £25 £1,850) Superannuation F S S U The succe ful applicant will be required to take up du on October 1, 1955

Applications, together with names of two pe sons to whom reference may be made, sho reach the Secretary by March 31, 1955

INSTITUTE OF UROLOGY

IN ASSOCIATION WITH ST PETER'S, ST PAUL'S AND ST PHILIP'S HOSPITAL

Full-time Biochemist (science degree or medic qualifications essential) required for work in co nection with urological disease Experience routine biochemical tests and an interest in r search necessary The post is of senior grad and Whitley Council scales will apply

Apply, Secretary, Institute of Urology, 10 He rietta Street, W C 2, stating age, qualificatio and experience, and enclosing copies of tw recent testimonials Closing date March 1 1955

UNIVERSITY OF CAMBRIDGE

Applications are invited for the office of Read in Industrial Management which has recently bee established in the Department of Engineering

Forms of application and further particula may be obtained from the Secretary General the Faculties, The Old Schools, Cambridge T closing date for the receipt of applications April 9, 1955

BACTERIOLOGIST OR MICROBIOLOGIS required for production work at Lister Institu of Preventive Medicine, Chelsea Bridge Roa London, S W 1 Previous experience desirab but not essential Salary according to qualifica tions and experience —Apply in writing, givi age and details of training, to the Secretary at t above address

UNIVERSITY OF READING

RESEARCH FELLOWSHIPS

Applications are invited for one or more Rerch Fellowships, for independent research, value 0 per annum

Full particulars may be obtained from the gistrar, to whom applications should be forrded by April 12, 1955

UNIVERSITY OF LONDON

Applications are invited for Turner and Newall search Fellowships in Engineering, Inorganic emistry, Physics or an allied subject, tenable m October 1, 1955, normally for three years the first instance Salary not less than £750 r annum, with family allowances and F S S U Information and application forms can be tained from the Academic Registrar University London, Senate House, W C 1 Applications st be received not later than April 16 1955

UNIVERSITY OF ABERDEEN

Senior Technician required for Clinical Chemry Department, Foresterhill, Aberdeen Wage scale £490 by £20 to £590, placing according qualifications and experience

Applications, in writing, to the Secretary, arischal College Aberdeen

---

UNIVERSITY OF NOTTINGHAM

Laboratory Technician, with experience, reired for the Chemistry Department Salary ale £440 to £480 per annum Annual leave enty-one working days Voluntary superannuan scheme

Application by letter to the undersigned

H PICKBOURNE,
Registrar

SENIOR TECHNICIAN REQUIRED AS ssistant to Laboratory Superintendent Must be nversant with requirements of large research hool engaged on problems connected with all anches of chemistry Skill in laboratory arts d experience of laboratory maintenance essenl Wage according to university technical resed scale Grade B—Apply, The Laboratory perintendent, Chemistry Department, The Unirsity, Edgbaston, Birmingham, 15

LABORATORY TECHNICIAN REQUIRED assist chief steward Experience in general boratory technique desirable Salary £340 to 80, according to age and experience—Applicans, with references, in writing to Mr W A ightman, Department of Organic Chemistry, he University, Leeds, 2

READER AND SENIOR LECTURERS OR ecturers in Physics—The Dean, College of Arts d Science, Baghdad, Iraq

APPOINTMENTS VACANT

IMPERIAL CHEMICAL INDUSTRIES imited Billingham Division, has several interestg vacancies for Physicists The Division has n expanding research programme and requires hysicists to carry out work on the development f physical methods and techniques and their aplication to chemical problems and analytical ethods There is also a requirement for Physists or Electrical Engineers who have made a road study of instrument technology or who wish take up work in the fields of instrument deelopment and management Candidates should e not more than 35 years of age and hold an onours degree Starting salaries will depend pon qualifications and experience—Write, giving ll details of age, qualifications and experience the Staff Manager, Imperial Chemical Induses Limited, Billingham Division, Billingham o Durham, quoting reference F 9

GRADUATE (CHEMIST OR PHARMACIST) quired for analytical work in Control Laboraory of pharmaceutical manufacturers The work fers a variety of experience in modern pharmautical analysis and control procedures Precus experience will be an advantage but applitions are also invited from persons recently alified A non-contributory pension and life surance scheme is in operation—Application rms from Eli Lilly and Company, Limited, asingstoke, Hampshire

---

IMPERIAL CHEMICAL INDUSTRIES LTD, as a vacancy for a Techno-commercial Assistant one of its subsidiary companies in the Far ast Candidates should be single not more an 30 years of age and must possess a degree chemistry Remuneration according to age d qualifications—Application should be made the Recruitment Section, Central Staff Departent, Imperial Chemical House, Millbank, Lonn, S W 1

GLAXO LABORATORIES LTD

Glaxo Laboratories Ltd invite applications from graduates in one of the biological sciences for two posts at their Stoke Poges Research Laboratories The work of one of the posts involves research into biochemical and immunological aspects of the preparation of virus vaccines and the other the tissue culture propagation of viruses Postgraduate experience is a necessity for both posts

Those interested should write to Personnel Manager, Glaxo Laboratories Ltd, Greenford, Middlesex

---

TECHNICAL ABSTRACTOR / STENOgrapher required by London Office of U S A Chemical Company Good knowledge of chemistry, German, French and typing is required Shorthand an advantage Five-day week, attractive salary would be paid—Write, giving full particulars to Box No 657, T G Scott and Son Ltd, 143-147 Regent Street, London W 1

BRITISH INSULATED CALLENDER'S Cables, Ltd invite applications for the following vacancy at their Leigh Works, near Manchester Graduate Physicist or Electrical Engineer for the Electro-Physical Laboratory The work involves the study of electrical properties of rubber and synthetic insulating materials under a wide range of physical conditions Investigational work relates to the performance of experimental cables embodying new and improved designs Candidates should have an interest in the practical use of all types of electrical measuring equipment, but previous industrial experience is not necessary—Applications, quoting reference A/26/54, should be addressed to the Staff Officer, B I C C, Ltd, Prescot, Lancs

---

ASSISTANT, PREFERABLY WITH LABORAtory experience required for research on behaviour of packaging materials under shock Use of electronic equipment will be involved Salary within range £250 to £520, according to experience Five-day week—Application forms from Secretary, Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey (Ref CM/2/2/1955)

METALS RESEARCH APPLICATIONS INvited from men with degree (or equivalent) for positions in Welding and Ferrous Sections of the Birmingham Laboratory of the Mond Nickel Co, Ltd Fields of investigation extremely broad, including (a) studies of techniques and metallurgy of the welding of corrosion-resistant and creep-resistant materials, and (b) properties of low and high alloy steels Positions suited to men with initiative and energetic temperament—Apply, stating age, qualifications, experience and salary required, to Manager, D and R Dept, The Mond Nickel Co Ltd Sunderland House, Curzon Street, London, W 1 Mark envelope "Confidential L 21"

JOSEPH LUCAS, LIMITED, HAVE AN INteresting vacancy in their research and development laboratories which would be suitable for a young graduate with honours degree in mathematics or physics The work is largely of a fundamental nature, and is concerned with acoustics and mechanical vibrations Previous industrial experience is not necessary—Please reply, giving qualifications, age, and any other relevant details to Personnel Manager, Joseph Lucas (Electrical), Ltd, Great King Street, Birmingham quoting reference PM/D/59

A GRADUATE IS REQUIRED FOR BASIC and applied research on the machining and cold forming of metals A good degree (or equivalent qualification) in engineering, science or metallurgy is required There are good prospects for advancement Commencing salary commensurate with qualifications and experience Pension scheme—Send full details, including age, experience, qualifications and present salary in confidence to Box 649 T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

BRITISH NYLON SPINNERS LIMITED REquire an Information Assistant in their Library and Information Section The work will be varied and includes indexing of technical literature and the making of literature surveys The minimum qualification is general certificate of education, advanced level, with chemistry as one subject, but persons with higher qualifications or experience in a technical library will be given preference The appointment is permanent and pensionable Five-day week—Apply in writing to Personnel Manager, Pontypool Mon

---

TUBE INVESTMENTS RESEARCH LABORATORIES

HINXTON HALL, CAMBRIDGE

Tube Investments, Limited, have set up long range Research Laboratories near Cambridge to study fundamental problems in the general fields of physics, chemistry metallurgy, electronics and engineering A senior graduate directly responsible to the Director of Research, is required to organize and co-ordinate the technical aspects of the greatly expanding programme of the laboratories, and the provision of laboratory and engineering facilities and services Salary according to qualifications and experience

---

TECHNICAL LIBRARIAN

WOMAN

Courtaulds Limited require a technical librarian (woman) for a new research laboratory at Coventry Candidates should have a knowledge of chemistry to degree standard and previous experience in an industrial technical library

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds Limited, 16 St Martin's-le-Grand, London, E C 1, quoting the reference number D 60

DENIS FERRANTI METERS LIMITED

BANGOR, NORTH WALES

Due to expansion of Design Laboratories a vacancy exists for an Assistant Chief Engineer A good degree and senior experience in the design of aircraft instruments or armaments essential, specialized knowledge of gyroscopes and/or servo systems would be an additional qualification Excellent prospects in expanding concern situated in North Wales coastal centre Assistance given, if desired, in obtaining accommodation

Applications, in confidence, to Chief Engineer

CHEMIST

HONOURS GRADUATE

Courtaulds, Ltd, has a vacancy in its Textile Research Laboratory at Bocking, Essex for a Graduate Physical Chemist who is interested in the basic physical problems of textile chemistry and is prepared to contribute original ideas in a developing situation Applicants should possess an honours degree and have had practical experience of research methods Age 25 to 33

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Ltd, 16 St Martin s-le-Grand, London, E C 1 quoting the reference number D 64

RESEARCH AND DEVELOPMENT

Courtaulds Ltd invite applications for the following vacancies in their Research and Development Laboratories Bocking, Braintree, Essex Graduate Textile Technologist, age 27-32 with industrial experience to work on textile dyeing and finishing Ref No D 61 Graduate Textile Technologist, to work on Research and Development in the field of textile manufacture Ref No D 62 Graduate Chemist, age 33 or less, for work on textile sizing Ref No D 63

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds Limited 16 St Martin's-le-Grand, London E C 1, quoting the appropriate reference number

---

LADY CHEMIST, GRADUATE OR H N C required for analysis of electroplating and allied solutions—Apply, Electro-Chemical Engineering Co Ltd 161 Queens Road Weybridge Surrey

---

T & H SMITH LTD HAVE A VACANCY in their works at Edinburgh for a qualified pharmacist or chemist, under 35 years of age, for interesting work in connection with the development and production of allergy preparations Superannuation scheme in force—Apply, giving full personal particulars to Works Director, T & H Smith Ltd Blandfield Chemical Works, Wheatfield Road Edinburgh 11

ALLEN & HANBURYS LTD, WARE Herts, require Research Chemist, organic, for Research Laboratories Candidates should have at least first- or second-class honours, or M Sc, and should be under 30 Previous experience in organic synthesis desirable but not essential The position is permanent, progressive and superannuated Five-day week—Apply, Personnel Manager

---

GRADUATE CHEMIST METALLURGIST or Chemical Engineer required to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel—Apply, Electro-Chemical Engineering Co, Ltd 161 Queens Road Weybridge Surrey

MULLARD RESEARCH LABORATORIES in Surrey have a number of vacancies for Physicists and Electronic Engineers with a good degree or equivalent qualification for work in a variety of projects, including

(1) SOLID PHYSICS AND SEMI-CONDUCTORS

(2) MAGNETIC MATERIALS AND APPLICATIONS

(3) MICROWAVE TECHNIQUES

(4) ADVANCED ELECTRONIC CIRCUIT TECHNIQUES INCLUDING TRANSISTOR APPLICATIONS

(5) COLOUR TELEVISION

(6) COMPUTORS AND SERVO-MECHANISMS

Some years' experience in one or more of these fields is desirable, but recent and prospective graduates are also invited to apply Mathematics graduates with experimental leanings are not excluded

Successful applicants will join teams engaged on research and advanced development projects Publication of original work wherever possible is encouraged

Salaries are based on qualifications, experience and age, and are in keeping with present-day levels General prospects within the organization are excellent

Apply to Personnel Officer, MULLARD RESEARCH LABORATORIES Cross Oak Lane, Salfords near Redhill, Surrey, quoting reference E R L

ENGINEERS BRITISH NYLON SPINNERS Limited would be interested to receive applications from Engineers for several appointments which are to be filled in the near future The duties will be in applied experimental work and will be of exceptional interest to mechanical engineers who can make the most of opportunities for original thought and application Sound general experience in mechanical engineering is called for, with a bias towards experimental work , and one of the appointments requires a wide experience in instrumentation In every case a good university degree is a desirable qualification followed by an apprenticeship and at least three years' industrial experience Inquiries are invited now, whether or not candidates are immediately available, and the fullest information will be given to those asked for interview, such interviews carry no obligation, but will enable candidates to meet the company's Chief Engineer and his staff and to measure at first hand the technical interest and career prospects —Apply in writing to Personnel Manager, Pontypool, Mon

---

INSTRUMENT DEVELOPMENT AN EXpanding programme of work has created new vacancies for development staff, to work on a wide variety of scientific investigations and instruments Applications are invited from qualified electronic and mechanical engineers, physicists and chemists preferably with some industrial experience —Write, giving full details and stating salary required Nash and Thompson, Limited, Oakcroft Road, Tolworth, Surrey

---

THE RESEARCH LABORATORY OF THE British Thomson-Houston Co Ltd require a Graduate in Metallurgy or Physics to join an expanding group working on the strength of metals, with particular reference to high temperature properties —Apply, quoting reference HJ and stating age, qualifications and experience to the Director of Research, The British Thomson-Houston Co Ltd , Rugby

---

APPLICATIONS ARE INVITED FROM physicists with honours degrees or their equivalent, for posts in the research laboratory of the British Thomson-Houston Co , Ltd The work involves investigations of photo-conductive materials and devices, but previous experience in this field is not essential —Apply, quoting reference WNB, and stating age, qualifications and experience, to the Director of Research, The British Thomson-Houston Co , Ltd , Rugby

---

MECHANICAL AND CHEMICAL ENGINEERS

Courtaulds, Limited, Chemicals Division, requires two graduate Mechanical Engineers and one Chemical Engineer for investigational and development work near Manchester The work is of an original nature in connexion with the development of chemical plants and processes for which a real interest in, and potential talent for, engineering development work as applied to large-scale chemical plant is of paramount importance The Mechanical Engineers must have served an apprenticeship for at least two years and all candidates must have had practical works experience Honours degree men preferred Age 25 to 35

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds, Limited, 16 St Martin's-le-Grand, London, E C 1 quoting the reference number H8 for Mechanical Engineers and H 9 for the Chemical Engineer

---

ASSISTANT CHEMIST REQUIRED A permanent progressive post is being created by an old-established, universally known Slough Company for a young man of ability, aged about 25 Under the direction of the Chief of Research his duties and scope will be wide and varied involving the control of industrial processes, electroplating, industrial research, etc This post is a responsible one demanding an enthusiastic worker with qualifications up to higher national certificate, higher school certificate, or Inter B Sc Some laboratory experience is essential Practical ability and a bent for works control are more important than academic honours Salary will be according to age, qualifications and experience, with good prospects of advancement Excellent working conditions, five-day week, pension scheme about to be introduced —Apply Box 659, T G Scott and Son, Ltd , 143-147 Regent St , London, W 1

CHEMIST REQUIRED FOR REsearch work on inorganic chemicals and metal extraction Applicants should have B Sc or A R I C , and some research experience would be preferred Permanent appointment with pension and life assurance Apply, stating reference NC F15, and details of age, qualifications and experience to

Personnel Officer (Staff),
Magnesium Elektron Limited,
P O Box No 6, Lumm's Lane,
Clifton Junction, Swinton,
near Manchester

THE RESEARCH DEPARTMENT OF A leading industrial organization situated in the south requires two graduates to undertake the expansion of an important research project connected with the raw materials of the industry The work involved, which offers ample scope for initiative and imagination, will appeal to organic chemists and biochemists who are interested in fundamental research on natural products and in applying the results of this research to the agricultural and manufacturing practices of the industry Applicants must have a first- or second-class honours degree and some postgraduate experience would be useful, although not essential The appointments will be to the regular staff and will be pensionable with starting salaries according to age and experience within the range £700 to £1,100 —Applications, giving full particulars will be treated in confidence Box No T 6208 Haddon's, Salisbury Square, Fleet Street, E C 4

THE LIBRARY OF A LARGE GROUP OF Chemical Manufacturing Companies requires a graduate in chemistry for information work Duties will include searching, summarizing, translating and abstracting chemical and patent literature, preparing subject surveys and reports, and obtaining technical information for the Research, Chemical Engineering and Sales Departments Ability to translate fluently chemical material from German and at least one other language is essential—knowledge of other languages would be an advantage The library is situated 30 miles north of London Applicants should be under 30 years of age, and be British subjects by birth —Write Box N 937, c/o 191 Gresham House, E C 2

CHEMICAL LABORATORIES OF PLANT Protection Limited, Yalding, require a young man aged about middle 20s of Inter B Sc standard for work on chemical formulation problems associated with crop protection —Applications to Technical Department, Plant Protection Limited, Yalding, Kent stating full particulars

---

THE DISTILLERS COMPANY, LIMITED

A Physicist or Physical Chemist, interested in the mechanical and electric properties of high polymers, is required a the Research and Development Department, Epsom, Surrey Duties would involve supervision of testing of a wide rang of experimental plastics, fibres and rubbers development of new test methods, an fundamental research on visco-elastic properties of polymers A good honour degree would be a minimum qualification previous experience in the field mentioned though desirable, is not essential This i a progressive post with excellent opportunities for the right person

Apply, Staff Manager, The Distillers Co Ltd , 21 St James's Square, London S W 1 Ref 10/55

A SCIENCE GRADUATE WHO IS INT ested in a progressive career in modern manu turing is required by a large and growing c pany with chemical interests During the last years the company has met its expansion n by the introduction of graduates of progres outlook who wished to make a career in moc industry, and who wished to develop in managerial and executive field without lo touch with technical matters Most of these i have read chemistry but it has appealed also the engineer or physicist who wished to veer a from the purely technical field The initial p tion, after training, will be the management c small process or production department position will be clearly defined in both respo bility and authority, and will be preceded by c ful training under senior graduate members T training will be continued long enough to ens the position is taken over with confidence T other positions of a similar nature will be av able later in the year and applications from terested graduates taking finals this summer, from men in the Services, will be considered n Upper age limit 27 years Commencing sal £650 to £850, depending upon the candida background, and this will be paid during the tr ing period At the end of training full scope be given for the use of ability and initiative progress will be related solely to merit All se positions are, without exception, filled from w in the company Strict confidence will be served —Please forward a brief outline of ba ground, etc , to Box 648, T G Scott and S Ltd , 143-147 Regent Street, London, W 1

YOUNG GRADUATE IN CHEMIST with physical or engineering bias required research and development of new cera materials and technical control of producti This is a new and interesting field offering gc prospects Commencing salary in the order £500 to £600 per annum, or more, according merit —Apply in writing to Neosid Ltd , Sto hills House, Welwyn Garden City, Herts

---

THE BRITISH LEATHER MANUF turers' Research Association requires an exp enced laboratory steward to undertake storeke ing and maintenance of laboratories Knowle of electrical and instrument work would be advantage Five-day week , staff cante pension scheme after one year's service Sal according to age and experience —Apply in w ing in the first instance, to The Direct B L M R A , Milton Park, Egham, Surrey

---

SENIOR PHYSICIST REQUIRED initiate a Nuclear Physics section in a w equipped research laboratory Location in Nor amptonshire —Box 661, T G Scott and Son, Lt 143-147 Regent Street, London, W 1

METALLURGIST IS REQUIRED FOR I vestigation of problems in the field of physi metallurgy The vacancy would suit a rec graduate · one or two years' industrial or search experience would be an advantage, but not essential —Applications should be address to the Director of Research, Aluminium Labo tories, Limited, Banbury Oxon

EEL COMPANY OF WALES LTD
(STEEL DIVISION)
PORT TALBOT
INVITES

lications from suitably qualified young men,
have completed their National Service, for
umber of posts in their Operational Research
partment

he Company operates the largest and most
dern integrated Steel Plant in Europe and is
expanding The plant is laid out on the
th Wales seaboard in spacious and pleasant
roundings with ideal working conditions Good
dential areas are reasonably close to the
rks

he Operational Research Department engages
the investigation of a wide range of stimulat-
problems concerned with all aspects of the
iency and development of a complex plant
re is ample scope for originality of approach
initiative

n attractive pension scheme is in operation

emoval expenses will be paid for a married
n to a maximum of 5 per cent of annual salary

acancies are available for

One PHYSICIST with a good honours degree preferably some industrial experience Starting salary in the range of £700 to £900

One STATISTICIAN with an honours degree in Mathematics and a few years experience Salary in keeping with experience and qualifications

Three or Four GRADUATES in either Science or Engineering who seek to apply their training to industrial problems Starting salary in the range of £550 to £650

Those wishing to apply should *write for official Application Form* to the

Personnel Superintendent
The Steel Company of Wales Limited,
P O Box No 3,
PORT TALBOT, Glam

MPERIAL CHEMICAL INDUSTRIES
nited seeks to fill the following vacancies in
earch work (1) A young woman honours
duate who has specialized in Zoology or pos-
ly Microscopic Botany The appointment will
concerned with Histopathological work in con-
tion with Chemotherapeutic Research (2) A
teriologist with a veterinary qualification The
ointment is concerned with research on the
motherapy of animal diseases Previous re-
rch experience is essential and preference will
given to candidates between 30 and 35 years
age (3) Organic Chemists to conduct Chemo-
rapeutic Research Candidates should hold a
D degree or have had an equivalent research
ring and should be under 30 years of age (4)
Biochemist to conduct research in the field of
motherapy Candidates should hold a Ph D
ree or have had an equivalent research train-
and should be under 30 years of age The
mpany's Research Laboratories are at present
ated in the North Manchester area but new
oratories are now in the course of erection in
rural area about twenty miles south of Man-
ster—Applications, with full particulars should
addressed to the Staff Manager, Imperial
emical (Pharmaceuticals) Limited, Fulshaw
ll Wilmslow, Manchester

QUALIFIED AND EXPERIENCED RE-
rch chemist required by food manufacturers in
Edinburgh district—Applications in full, stat-
qualifications and experience to Box 660,
G Scott and Son, Ltd, 143-147 Regent Street,
ndon, W 1

LANKRO CHEMICALS LIMITED OF
les Manchester, offer an unusual opportunity
h considerable scope for a highly qualified
mist of proven ability Applications are in-
d for the post of Senior Research Chemist
high standard in organic chemistry with keen
erest in physical chemistry and at least five
rs' industrial experience are required Some
ministrative experience is desirable The com-
y manufactures plasticisers, surface active
micals and auxiliaries for the leather and
tile industries Salary will be by negotiation
d a contributory pension scheme is in opera-
—Applications giving full particulars, should
addressed to The Managing Director

ALLEN & HANBURYS LTD, WARE,
rts require Assistant Chemists, preferably of
er science standard, for their Organic Re-
arch Laboratories Opportunity for further
dy is available Five-day week—Apply Per-
nnel Manager

NUCLEAR REACTOR PROJECT DESIGN STUDY GROUP

A unique opportunity is offered to young men with initiative and imagination, to study nuclear power and propulsion

Applications are invited for the following posts

(1) PROJECT ENGINEER, to carry out feasibility studies on small high temperature system Background in aero-engine design would be an advantage Knowledge of heat transfer and fluid dynamics essential

(2) RESEARCH METALLURGIST, to engage in research on new materials Some knowledge of high temperature alloys, ceramics or liquid metals would be an advantage

(3) PHYSICIST, to engage in experimental research on existing reactors and assist in nuclear design calculations on new types

Some knowledge of nuclear physics is desirable for (3), but is not essential for (1) and (2)

Honours degree or equivalent qualifications essential

Age 23 to 30 years

Initial salary up to £1,000 per year, depending on age and experience

Reply, giving full details of career to Box 658, T G Scott and Son Ltd 143-147 Regent Street, London W 1

RESEARCH CHEMISTS AND PHYSICISTS with university degrees or equivalent and Research Assistants with Inter B Sc or general certificate of education in science subjects are required urgently by the Central Research Department of The Morgan Crucible Co Ltd to take part in various projects of a varied and interesting nature Scope exists for scientists interested in the relatively little-explored field of reactions between materials at temperatures between 1,200° C and 2,500° C in powder metallurgy, in the field of semi-conductors, in the development of new physical testing methods, and in special problems associated with the physics and chemistry of carbon, graphite, refractory oxides, silicon carbide and metal-ceramics The laboratories of the department employ 100 people and are modern and excellently equipped Applicants called for interview will be given an opportunity to see some of the work going on, and good salaries dependent on age qualifications and experience will be offered to men and women chosen to join an expanding department where there is ample scope for keen intelligence and practical commonsense The laboratories are situated at Battersea and are accessible from most parts of London and the southern suburbs, for those interested in furthering their studies, wide opportunities exist at Battersea or Chelsea Polytechnics which are only 10 minutes away Five-day week, good recreational facilities and staff pension scheme—Apply in writing to the Staff Manager, Battersea Church Road S W 11

ENGINEER, WITH ELECTRICAL OR PHYSICIST degree, required for development work on testing equipment for telecommunication cables Permanent and pensionable position at salary commensurate with experience and qualifications —Please apply, giving full particulars, to Personnel Officer, Southern United Telephone Cables, Ltd, Dagenham Dock, Essex

---

GRADUATES, WITH AND WITHOUT EXPERIENCE are invited to apply for interesting and progressive positions in the Research Laboratories of a large manufacturing organization Vacancies in the following fields are offered to suitable applicants The overall performance of communication systems of all types Centimetric research micro-wave links and associated equipment and problems Transistor development and applications Circuit development for telecommunications and television—Applications for interview should be made to Mr P J Rogers Personnel Manager, Standard Telecommunication Laboratories Limited, Progress Way, Great Cambridge Road, Enfield Middlesex

---

Advertisers please note You must add "Apply Employment Exchange" unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

FISONS PEST CONTROL, LIMITED, CAMBRIDGE, has vacancies in Chemical Division for Chemists to originate and develop new manufacturing processes for organic chemicals Initial salary range £550 to £800 per annum, according to age, qualifications and experience Permanent, progressive positions Good canteen facilities Lodging accommodation available—Write (quoting No 1004), stating age, fullest particulars and salary required, to Personnel Manager, Fisons Pest Control, Ltd, Bourn, Cambridge

GRANTS & SCHOLARSHIPS

DUBLIN INSTITUTE FOR ADVANCED STUDIES
SCHOOL OF THEORETICAL PHYSICS

The Governing Board of the School of Theoretical Physics of the Dublin Institute for Advanced Studies is prepared to award a limited number of scholarships, value £350 per annum, tenable in the school during the academic year, 1955-6

For further particulars and forms of application candidates should apply immediately to The Senior Clerk, Dublin Institute for Advanced Studies, 64 Merrion Square, Dublin Completed applications should reach the Senior Clerk on or before June 1, 1955

IMPERIAL COLLEGE
BURSARIES FOR POSTGRADUATE STUDENTS

Bursaries are available for Session 1955-56 to suitable persons for Courses of Postgraduate Study (not research) in the following subjects Civil Engineering, Mechanical Engineering, Electrical Engineering, Chemical Engineering Applicants must be graduates, who have spent at least one year away from University since graduation preferably in Industry The bursaries will be of value £300 to £400 according to circumstances

Applications should be sent to the Deputy Registrar City and Guilds College, Exhibition Road, London, S W 7, not later than April 18 1955

THE BRITISH FEDERATION OF UNIVERSITY Women announce Ida Smedley MacLean Junior British Scholarship, 1955-56 Value £100 for research or training for research Open to women graduates of the British Isles, under 30 years of age (extension for national service) Summer Research Grant Reid Hall, Paris, 1955 providing two months' residence from July 25 for a woman graduate to pursue scholarly research—Details from Research Applications B F U W Ltd, 17A Kings Road London, S W 3 Applications by April 25 1955

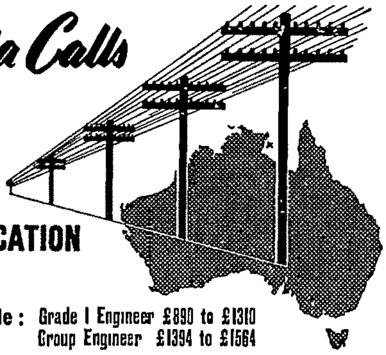
RAMSAY MEMORIAL FELLOWSHIPS FOR Advanced Students of Chemistry The Trustees will consider in June applications for three Ramsay Memorial Fellowships for Advanced Students of Chemistry One of the Fellowships will be limited to candidates educated in Glasgow, who can apply to be considered for either Fellowship The value of each Fellowship will be £450 per annum to which may be added a grant for expenses of research not exceeding £100 per annum The Fellowships will normally be tenable for two years—Full particulars can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, London, Gower Street W C 1 Completed application forms must be received not later than April 21 1955

FOR SALE AND WANTED

CORNEAL AND CONTACT LENSES EASY payments arranged if desired—For details and free booklet write David Blackstone, Ltd, Dept 235, Triumph House, 189 Regent Street, London, W 1 Tel Regent 3516-7 Consulting Rooms in Leeds, York, Leicester, Middlesbrough Newcastle etc

---

VICKERS PROJECTION MICROSCOPE, Model 1 Pointolite illumination, Micro equipment ×4, ×6 ×10 eyepieces, 25 mm 16 mm, 4 mm, metallurgical objectives Macro equipment, vertical and oblique illumination, 5 75 in and 1 375 in macro objectives Polarizing attachment Mirror, lens and Abbé condenser for transmitted light Equipment can be inspected by arrangement—Inquiries to International Alloys, Ltd, Aylesbury 1010, Ext 17



Australia Calls

TELECOMMUNICATION ENGINEERS

Revised Salary Scale: (In £A) Grade I Engineer £890 to £1310
Group Engineer £1394 to £1564

AUSTRALIA is developing rapidly and urgently needs professionally qualified electrical, mechanical and civil engineers to assist in the expansion and maintenance of its national telephone, telegraph, radio and television services

QUALIFICATIONS Engineers academically qualified for Membership of main Institutions of Engineers.

STARTING SALARIES: According to qualifications and experience. Graduates £932 to £1058

CONDITIONS OF APPOINTMENT · Permanent appointment to the Postmaster-General's Department Free passages for appointee and dependants Initial accommodation provided In approved circumstances, special settling-in allowances Full salary from date of embarkation Superannuation, annual and sick leave conditions Good opportunity for advancement

FOR FURTHER DETAILS Engineers qualified or about to qualify, enquire from the Australian Post Office Representative, Australia House, Strand, London, W C 2

THE FARADAY SOCIETY

A GENERAL DISCUSSION
on
MICROWAVE AND RADIO FREQUENCY SPECTROSCOPY
will be held from
April 4–6, 1955, at The University, Cambridge.

The Discussion will be divided into four main sections

I. Microwaves
II Nuclear magnetic resonance
III Paramagnetic resonance
IV Quadrupole spectroscopy.

Full particulars regarding application for accommodation and preprints may be obtained from The Faraday Society, 6, Gray's Inn Square, London, W.C 1

A GENERAL DISCUSSION
on
THE PHYSICAL CHEMISTRY OF ENZYMES
will be held from
August 10–12, 1955, at The University, Oxford

The Discussion, which is being arranged by the Colloid and Biophysics Committee of The Faraday Society, will be divided into two main topics

I Kinetics and mechanisms
II Characterisation and physical properties.

Full particulars regarding application for accommodation and preprints will be issued in due course The Faraday Society, 6, Gray's Inn Square, London, W C 1

PRESS for making KBr and KCl DISKS
as used in I-R and U-V solid state study.

INFRA-RED CELLS
Variable path-length cells for liquids
Fixed path-length cells for liquids and gases
(Made by Research & Industrial Instruments Co)
Catalogue CH388/N3 free on application from

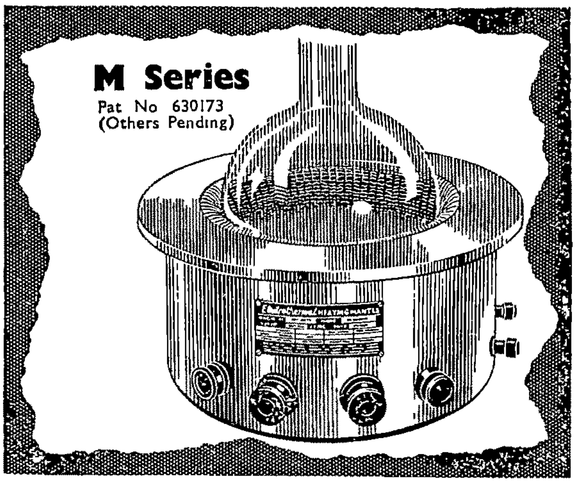
HILGER & WATTS LTD.
98 St. Pancras Way, London, N.W.1

HIGH SPEED VIBRATION MILL
(100 *C P.S.*), ideal for KBr disk technique and other fine and fast grinding

ROTATING ELECTRODE (*graphite disk*) **SPARK UNIT** for the study of lubricating oils, other liquids and powders

Descriptive literature on application

RESEARCH & INDUSTRIAL INSTRUMENTS CO.
1 Laycock Street, Islington, London, N 1. ARChway 5488

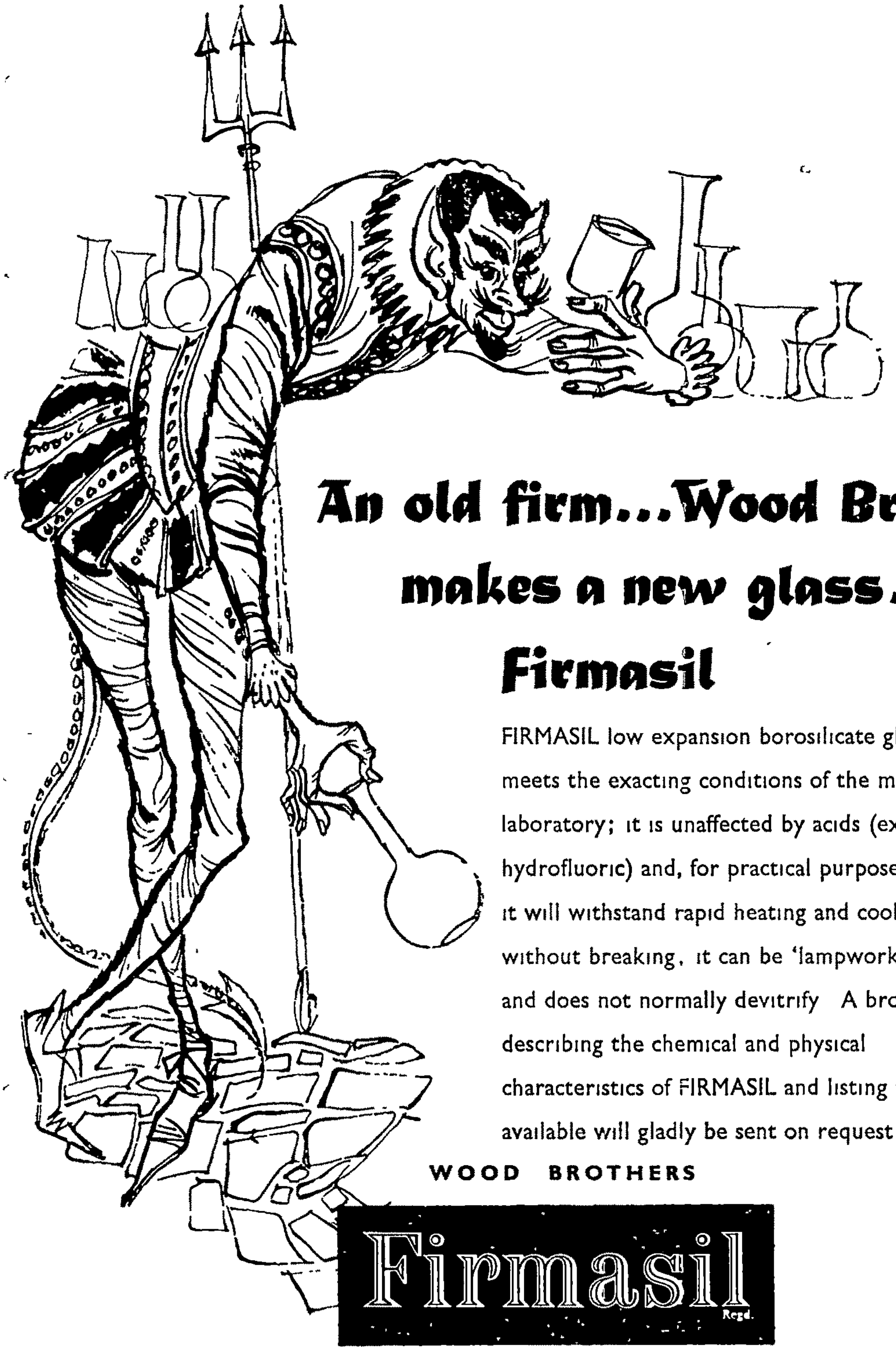


HEATING MANTLES

This range of Electrothermal Heating Mantles now covers all flask sizes up to 200 litres—round or flat bottomed flasks are easily accommodated Available from your usual Laboratory Suppliers

Please request D.S.I.R. Report No. 50

Electrothermal Engineering Ltd.
270 NEVILLE ROAD, LONDON, E.7 Telephone GRAngewood 00



An old firm...Wood Brothers makes a new glass...

Firmasil

FIRMASIL low expansion borosilicate glass-ware meets the exacting conditions of the modern laboratory; it is unaffected by acids (except hydrofluoric) and, for practical purposes, by alkalis; it will withstand rapid heating and cooling without breaking, it can be 'lampworked' easily and does not normally devitrify A brochure describing the chemical and physical characteristics of FIRMASIL and listing the range available will gladly be sent on request

WOOD BROTHERS

Firmasil Regd.

RESISTANT GLASSWARE

Wood Bros Glass Co Ltd
Barnsley Yorkshire

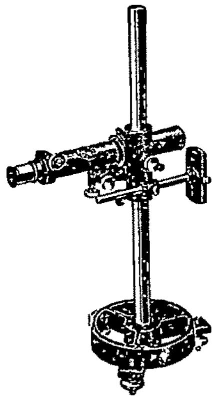
LARGE READING TELESCOPE

From Four Feet to Infinity

The Large Reading Telescope can be focused from 4 ft. to infinity or down to approximately 18 in with a supplementary lens, and has a magnification of × 10 The micrometer eyepiece with a sighting cross-line can be replaced by an eyepiece with a 100 division scale

Price (Telescope and Stand) **£21**

Please write for further details to

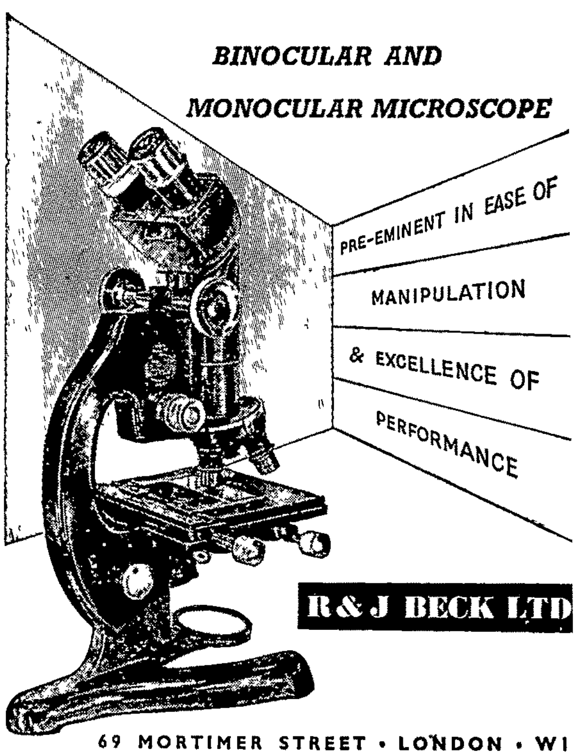


C. Baker OF HOLBORN LTD. EST. 1765

METRON WORKS · PURLEY WAY · CROYDON
Showrooms 244 High Holborn, London, W.C.1

BECK NO.48

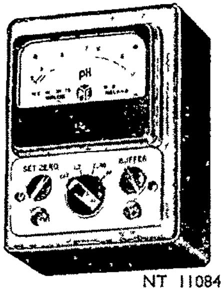
BINOCULAR AND
MONOCULAR MICROSCOPE



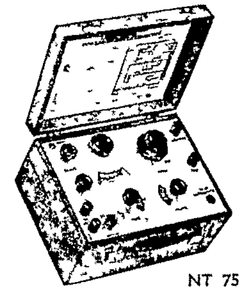
R & J BECK LTD

69 MORTIMER STREET · LONDON · W1

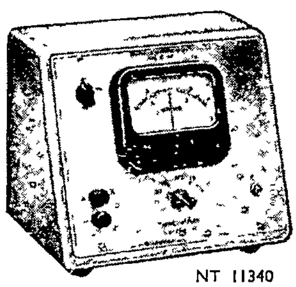
The following outstanding instruments are now available . . .



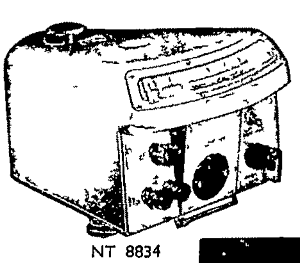
1 NT 11084



3 NT 7569/P



2 NT 11340



4 NT 8834

1 MINIATURE pH METER — for on-the-spot determinations in the plant or in the field and for routine laboratory measurements

2 SENSITIVE D C MICROVOLTMETER This portable instrument provides the sensitivity of a freely suspended reflecting galvanometer in a robust, compact form It also operates as a D C Amplifier with very low drift

3 PORTABLE POTENTIOMETER—a robust compact instrument suitable for both workshop and laboratory use

4 "SCALAMP" FLUXMETER provides exceptional performance, fitted with controlled return-to-zero device

Please write now for your copy of the new catalogue 'J'

SCIENTIFIC PYE INSTRUMENTS

Affiliated Companies —
Pye (Canada) Ltd , 60 Front St West, Toronto, Ontario, Canada
Electronic Industries Imports Pty Ltd ,
139, Bouverie St , Carlton, N 3, Victoria, Australia
Pye (N Z) Ltd , P O Box 2839, Auckland, New Zealand

W G PYE & CO LTD GRANTA WORKS · CAMBRIDGE ENGLAND

Printed in Great Britain by FISHER, KNIGHT & Co , LTD , The Gainsborough Press, St Albans, and published by MACMILLAN & Co , LIMITED, at St Martin's Street, London, W C.2, and ST MARTIN'S PRESS, INC , 103 Park Avenue, New York 17, N Y , U S A —Saturday, March 5, 1955

NATURE

'To the solid ground
Of nature trusts the Mind that builds for aye'—Wordsworth

VOL 175, No 4454 SATURDAY, MARCH 12, 1955 TWO SHILLINGS

PHYSIOS
LIBRARY
4.21.55

THE Newton

LONG WORKING DISTANCE ATTACHMENT

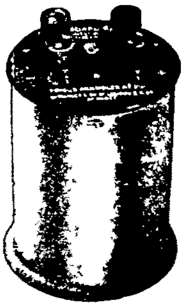
. provides a working distance of 12·8 mm between object glass and specimen when fitted to a standard microscope in conjunction with a conventional 4 or 8 mm objective

A further important feature is that the use of this attachment eliminates image reversal and thus further facilitates examination and manipulation of specimens.

Write for further details to Metropolitan-Vickers Electrical Co, Ltd, Trafford Park, Manchester, 17
Member of the A E I Group of Companies N/A 131

Tinsley

STANDARD CADMIUM CELLS



Single and double types in wooden cases or in metal cases as illustrated

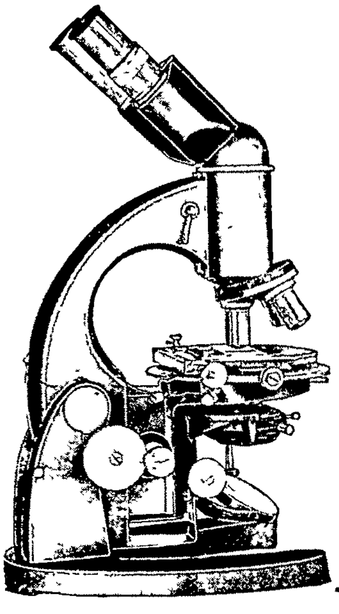
Reliable single or double miniature types mounted in plastic cases, E M F 1·01859 abs. volts at 20° C Temp. coeff —40 μV/1° C. Low internal resistance.

Dimensions $3\frac{1}{4}$ in × $1\frac{5}{8}$ in × $1\frac{3}{16}$ in.

Non-temperature coefficient cells for industrial use.

All types of unmounted standard cells can be supplied in quantity from stock.

H. Tinsley & Co., Ltd., Werndee Hall, London, S.E.25
Telephone: ADDiscombe 1400 and 3680



It's the ease of manipulation that counts . . .

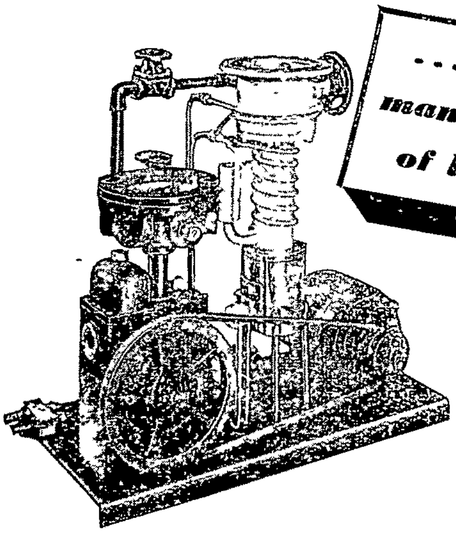
. allied, of course, with first-class optical equipment. The Baker Series 4 Microscope, with its close-coupled controls placed in a natural position, and its excellent workmanship and finish, is an instrument with which you will be proud to work. Write now for details :

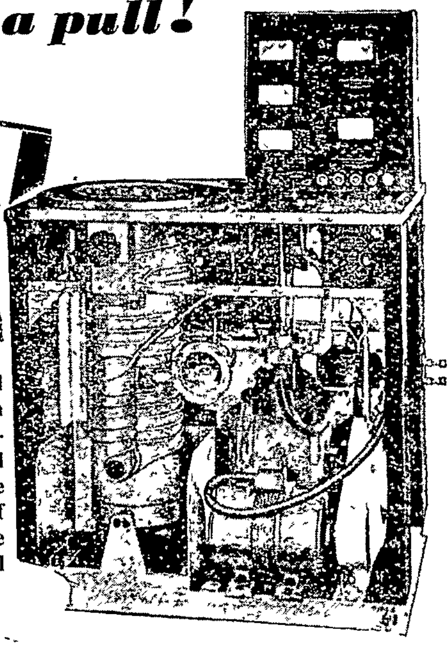
C. Baker
OF HOLBORN LTD. EST 1765

Metron Works · Purley Way · Croydon · Surrey (Croydon 6644/9822)
Showrooms : 244 High Holborn · London · WC1

VACUUM 'PACKS' *with a pull!*

... from TEN to many HUNDREDS of litres/second!





To meet the many and varied demands of scientific research and production, Edwards factory pre-fabricated Combined Vacuum Pumping Units are available in a range of standard models, or may be ordered to suit individual requirements.

W. EDWARDS
& CO (LONDON) LTD
MANOR ROYAL CRAWLEY SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

for better vacuum service

BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

CASELLA LONDON

VERNIER READING MANOMETER

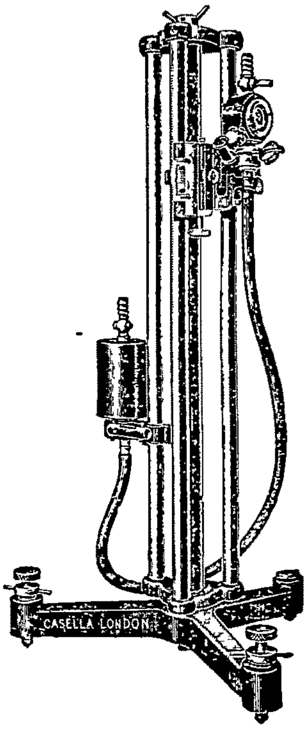
Accurate readings of pressures up to 100 cm. head of water, with readings to 0·05 mm.

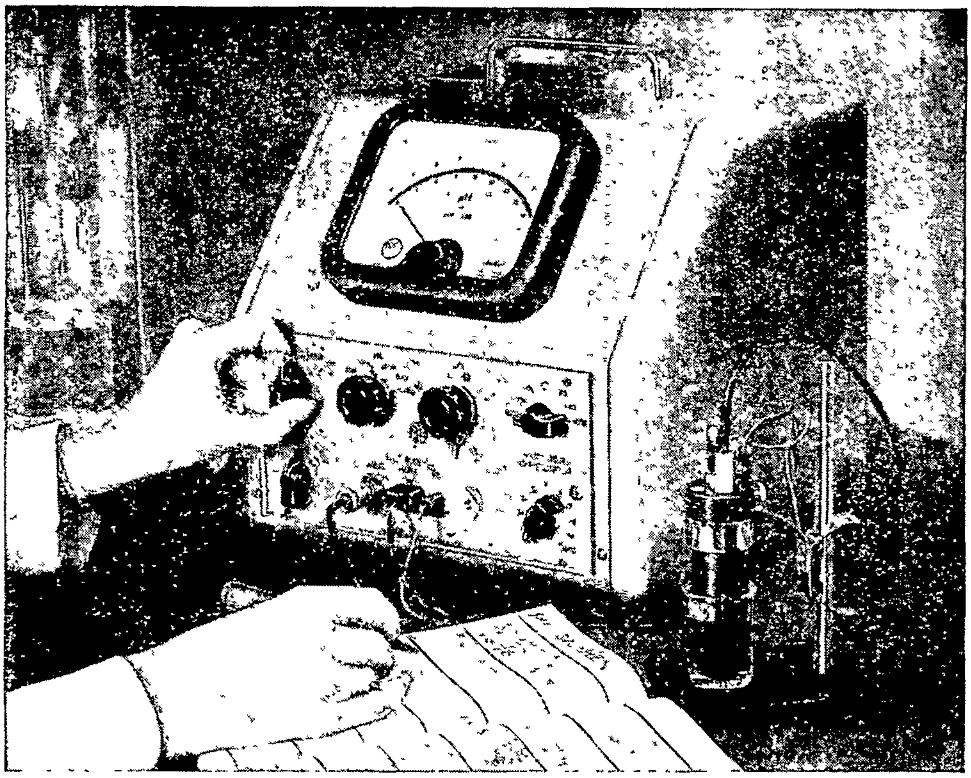
AVAILABLE FOR IMMEDIATE DELIVERY

Particulars from

C. F. CASELLA & CO. LTD.
Regent House, Fitzroy Square
LONDON, W.1
Telephone ★EUSton 3944

Member Scientific Instrument Manufacturers' Association of Gt Britain





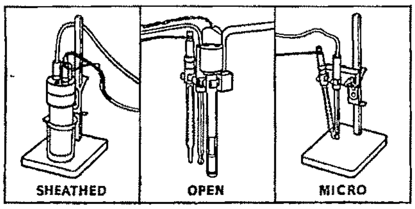
Ask users about the **PYE pH METER AND MILLIVOLTMETER**

DIRECT READING — MAINS OPERATED

Many leading industrial laboratories are using the Pye Universal pH meter and millivoltmeter to their complete satisfaction Read what The British Aluminium Company Limited says

" we write to inform you that our recommendations for the purchase of a number of these equipments for use in our Routine Laboratories have been accepted You can expect, therefore, within the next week or so to receive orders from a number of our factories . We feel you would like to hear from us this tangible proof of how satisfactory we found your instruments "
Signed Director of Research

May we send you details of this and other instruments in our comprehensive pH range?



Electrode Kit to make up all the assemblies illustrated and all necessary accessories are supplied complete with the instrument

STANDARD EQUIPMENT IN MANY LEADING LABORATORIES

SCIENTIFIC PYE INSTRUMENTS

W G PYE & CO LTD., GRANTA WORKS, CAMBRIDGE, ENGLAND

W G 50

Triphenyl Phosphite

Triphenyl Phosphite is a chemical for which several interesting uses have been established. For example, in the manufacture of alkyd resins and other paint media, it gives products of superior colour and clarity. Another application is in the preparation of alkyl halides difficult to prepare by more orthodox methods. Triphenyl Phosphite has been suggested as an oil additive, a fireproofing agent for natural and synthetic fibres and a termite repellent. Triphenyl Phosphite, a pale straw coloured liquid, is now available in commercial quantities

ALBRIGHT & WILSON

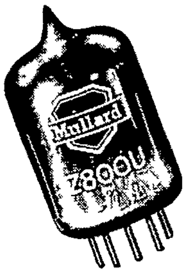
ORGANIC PHOSPHORUS
COMPOUNDS

ALBRIGHT & WILSON LTD 49 PARK LANE LONDON · W.1 Tel GROsvenor 1311

TBW453

STABILISERS & REFERENCE TUBES

Characterized by close tolerance burning voltages, very small voltage fluctuations, freedom from sudden large jumps throughout working current range, and long-term stability.

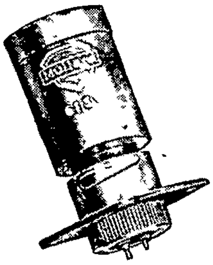


TRIGGER TUBES

Cold cathode tubes for particle counters and very low current stabilisers

ELECTROMETERS

Triode and pentode octal and subminiature types for use with radiation monitors, photocells and other devices where a high input impedance is essential

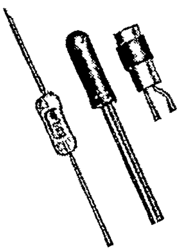


PHOTOCELLS

Vacuum and gas-filled photoelectric, and lead sulphide photoconductive types for light-activated relays and infra-red applications.

SPECIAL QUALITY VALVES

Special counterparts of popular types, designed and manufactured to withstand shock and vibration and to provide extra all-round reliability



SEMI-CONDUCTOR DIODES & TRANSISTORS

A range of germanium diodes and transistors for scaling circuits, very low power H T generation and for trigger circuits

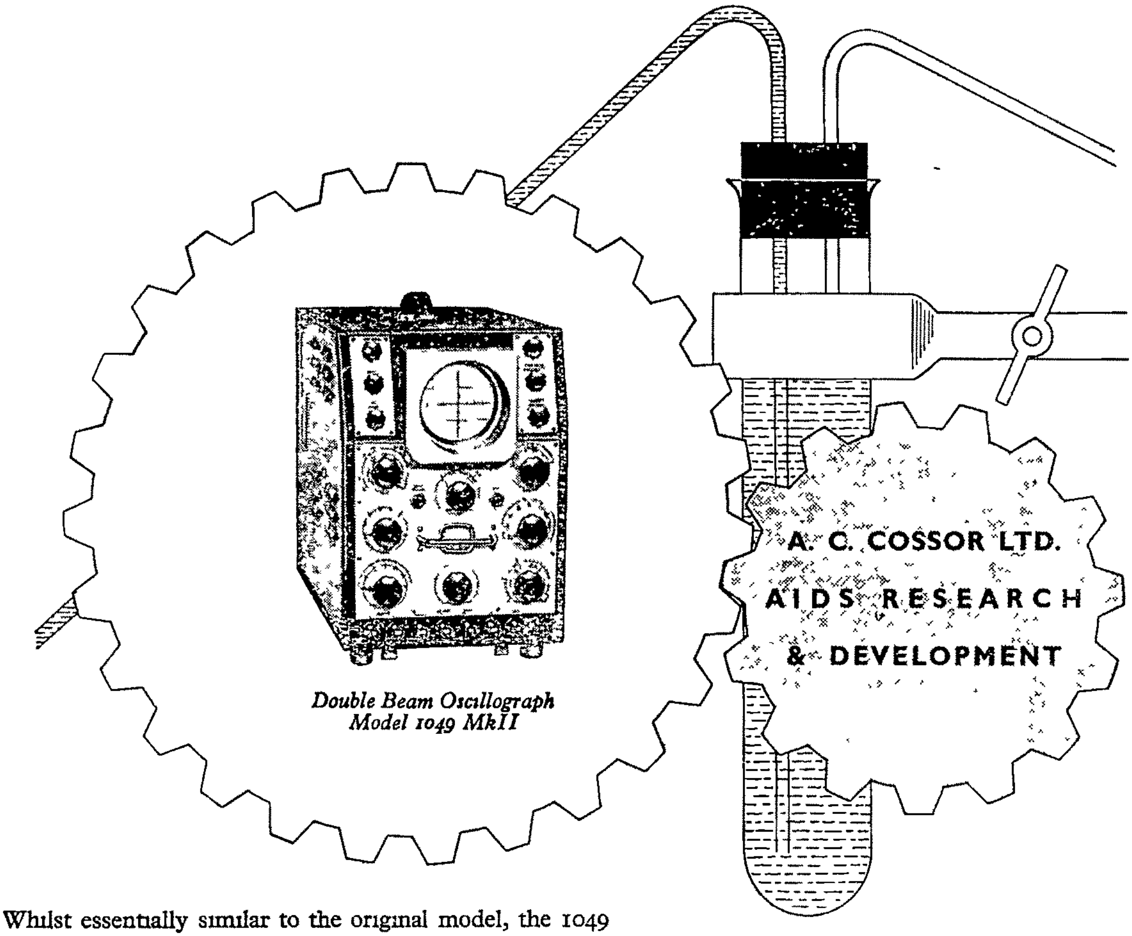
Valves and Tubes for Nuclear Physics

Among the valves and tubes in Mullard's comprehensive range are many that are suited for the most specialised and complex applications. Whatever your interest in electronic valves and tubes, your enquiries will be welcomed at the address below where full technical details and characteristic curves are available

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT.,
CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W C 2

MVT155



Double Beam Oscillograph
Model 1049 MkII

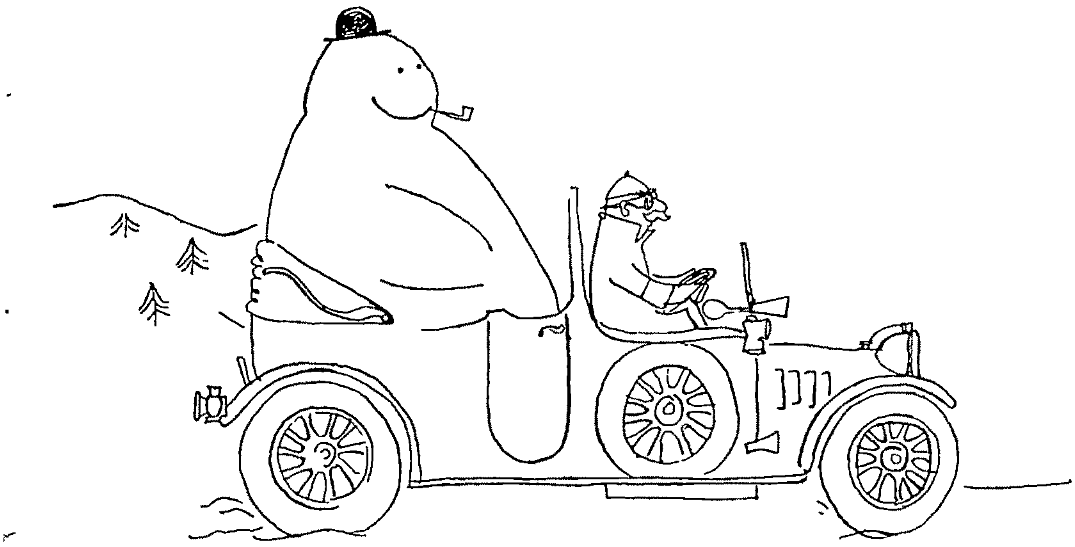
Whilst essentially similar to the original model, the 1049 Mk II provides added reliability against high voltage breakdown by the use of a sealed, oil-filled E H.T. power transformer The instrument meets the requirements of Industry and the Research fields of Physics and Medicine by providing an oscillograph for the display and measurement of phenomena of zero or very low frequency and those where amplifier bandwidths of up to 100 Kc/s are required The oscillograph incorporates the Cossor 4" flat-screen Double Beam tube (type 89) operating at 2 Kv but provision is made for operation at 4 Kv when maximum spot brightness is required. The amplifier circuits are direct-coupled throughout and provide independent amplifying channels for the Y1 and Y2 Beams with a gain of 900 and 25 respectively from zero frequency to 100 Kc/s Input signal voltages and frequency may be measured on either channel using the calibrated dials and special anti-parallax graticule The direct-coupled Time Base is arranged to provide a repetitive or triggered scan with a time range of 1 5 seconds to 150 micro-seconds and can be synchronized fron a pulse derived either from the internal worl circuits or from an external source. A continuously variable control adjusts the amplitud of the sync. or trigger signal and selects th polarity of the pulse from which synchronizatio is desired "Z" modulation system is incorporated for time-marking purposes. Stabilization against mains variations up to 10% i provided for amplifiers and cathode ray tub supplies. Long period stability is reached withi 5-10 minutes of switching on. A pre-amplifie (Model 1434) and photographic recording equipment is available for this oscillograph

The Technical Advisory Staff of the Cossor Instrument Division is always at your service

COSSOR ELECTRONIC INSTRUMENTS

Please address enquiries to
COSSOR INSTRUMENTS LIMITED (Dept. 34) · HIGHBURY GROVE · LONDON, N.5
Telephone CANonbury 1234 (33 lines) *Telegrams* Cossor Norphone London *Cables* · Cossor Londo

C I



Purer than the driven snow!

Ask T B. Ford for the answer to any filtration problem, and a perfectly pure and lucid filtrate is yours Ford's are experts in filtration. They make filtration media for every type of filter—and the standard of efficiency is unsurpassed.

From Ford's, you can obtain filtration media so efficient that they can be used to remove contaminating bacteria and moulds, thus sterilizing the liquids passed through them. This thorough filtration is achieved by the careful, precise admixture of asbestos fibres and cellulose, providing a mat that retains a high degree of porosity and permits a high rate of flow. Ford's Sterimats and Claraid not only filter but adsorb any micro-organisms that would spoil an otherwise stable, immaculate, crystal-clear filtrate

Twenty years of continuous laboratory research and experiment have made T B. Ford Ltd. *the* authority on every aspect of filtration media And they make the best in the world

This laboratory service is filtration NEWS!

Ford's provide a laboratory service, staffed by a team of experts, which is available to all manufacturers, free of charge Some manufacturers, with their own fully-equipped laboratories, simply want Ford's to check and confirm their own research findings. Others call upon Ford's to solve some particular problem in their filtration process, whether directly concerned with the media itself or not. Whatever the problem, Ford's will gladly undertake the necessary laboratory research. Write to T B Ford Ltd, Laboratory Service, 101 High Holborn, London, W C 1

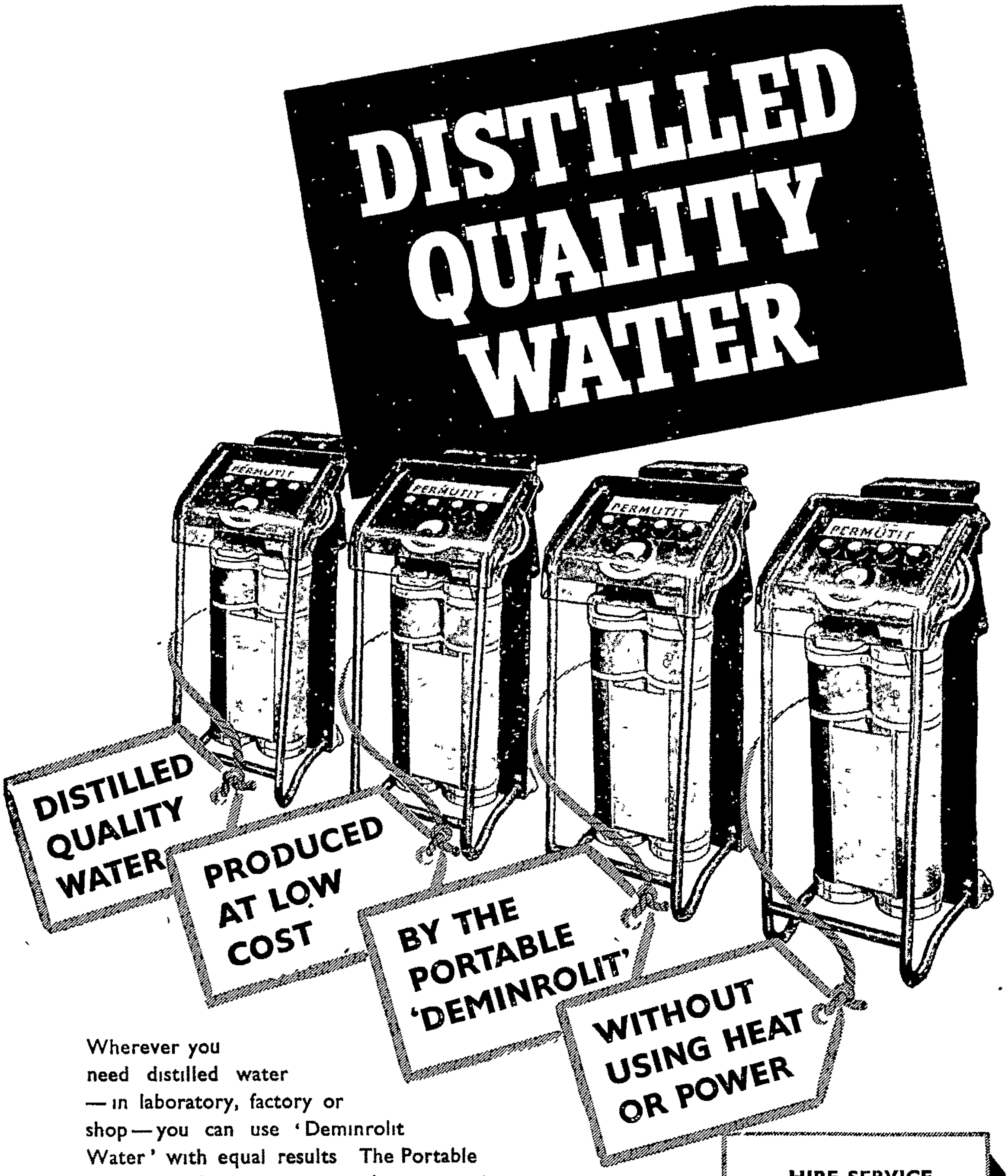
Famous chemical products are filtered by FORD'S

T. B. FORD Ltd

FORD 428 MILL

REGISTERED TRADE MARK

T B. FORD LTD., TECHNICAL ADVISERS ON FILTRATION MEDIA AND MANUFACTURERS OF STERIMATS, CLARAID, FILTER PULP AND FILTER PAPER



Wherever you need distilled water — in laboratory, factory or shop — you can use 'Deminrolit Water' with equal results The Portable 'Deminrolit' plant operates by ion exchange and delivers water substantially free from dissolved solids. Running costs are measured in pence instead of in pounds, and you can thus use distilled quality water for many purposes where the cost of distillation would prove prohibitive

Please write for Technical Publication No 62 which gives full details.

HIRE SERVICE

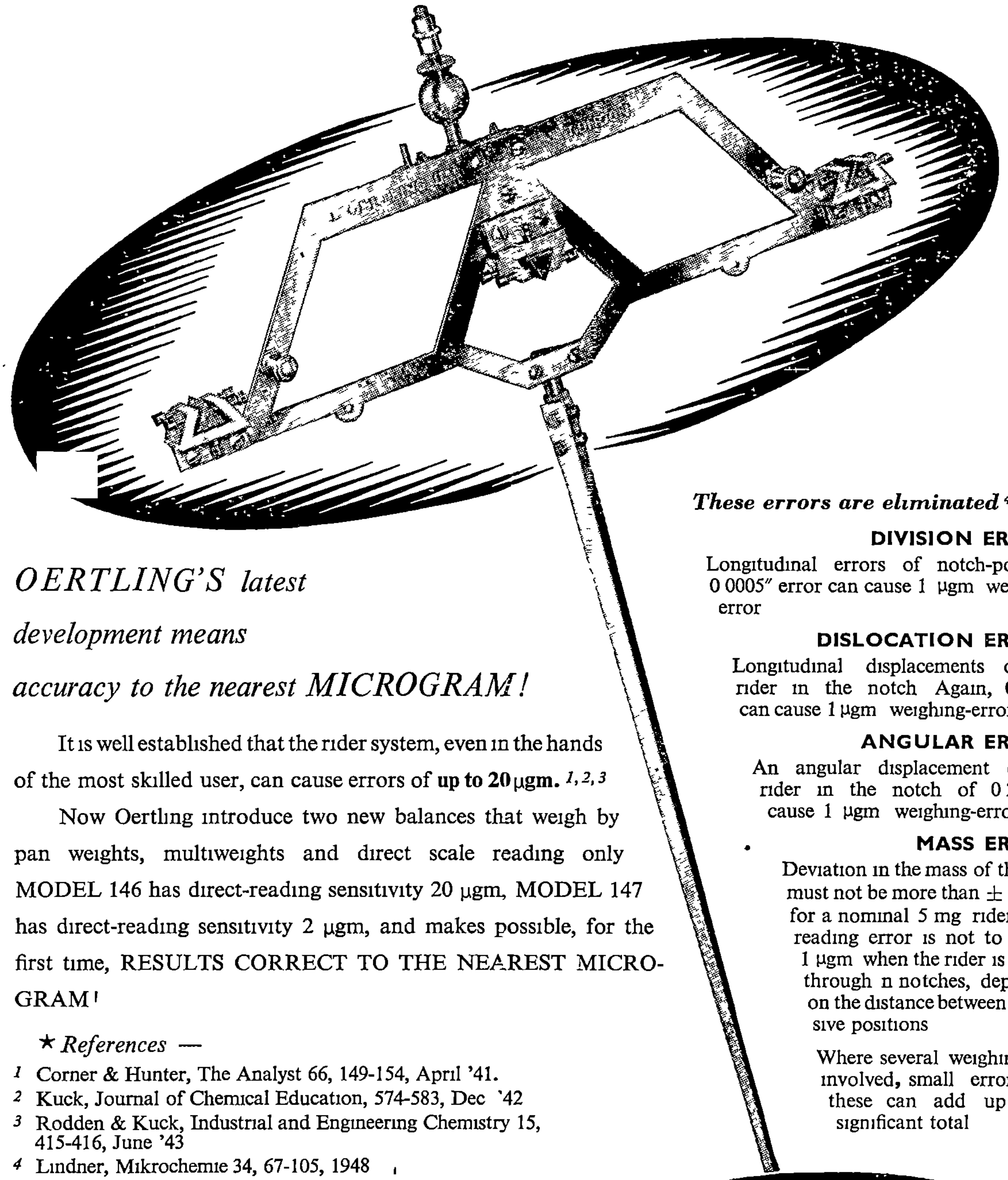
Why not try demineralised water in your industry? You can do so easily and cheaply by hiring from us, at a nominal rental for a trial period, the latest Mark II Model Portable 'Deminrolit' Plant. Details of this service will gladly be supplied on request.

PERMUTIT 'DEMINROLIT'

THE PERMUTIT COMPANY LIMITED

(Dept V H 173), Permutit House, Gunnersbury Avenue, London, W.4. *Telephone : CHIswick 6431*

Look No Riders!



These errors are eliminated[4]

DIVISION ERRORS

Longitudinal errors of notch-position 0·0005″ error can cause 1 μgm weighing-error

DISLOCATION ERRORS

Longitudinal displacements of the rider in the notch Again, 0·0005″ can cause 1 μgm weighing-error

ANGULAR ERRORS

An angular displacement of the rider in the notch of 0·2° can cause 1 μgm weighing-error

MASS ERRORS

Deviation in the mass of the rider must not be more than $\pm \frac{50}{n}$ μgm for a nominal 5 mg rider if the reading error is not to exceed 1 μgm when the rider is moved through n notches, depending on the distance between successive positions

Where several weighings are involved, small errors like these can add up to a significant total

OERTLING'S latest development means accuracy to the nearest MICROGRAM!

It is well established that the rider system, even in the hands of the most skilled user, can cause errors of **up to 20 μgm.** [1,2,3]

Now Oertling introduce two new balances that weigh by pan weights, multiweights and direct scale reading only MODEL 146 has direct-reading sensitivity 20 μgm, MODEL 147 has direct-reading sensitivity 2 μgm, and makes possible, for the first time, RESULTS CORRECT TO THE NEAREST MICROGRAM!

★ *References* —

[1] Corner & Hunter, The Analyst 66, 149-154, April '41.

[2] Kuck, Journal of Chemical Education, 574-583, Dec '42

[3] Rodden & Kuck, Industrial and Engineering Chemistry 15, 415-416, June '43

[4] Lindner, Mikrochemie 34, 67-105, 1948

Please send for full details to —

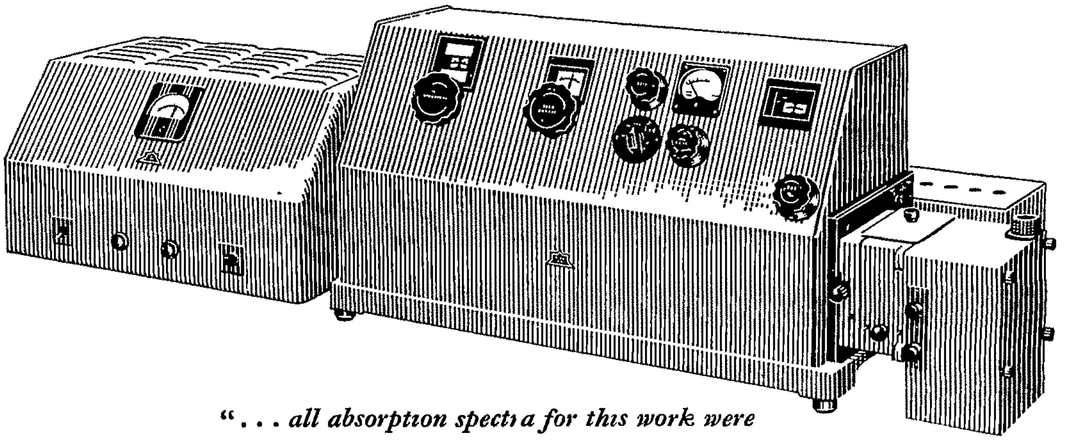
L Oertling Ltd, Cray Valley Rd, St Mary Cray,
Orpington, Kent. 'Phone: Orpington 25771 (5 lines)

OERTLING

TAS/OR 373

RELIABLE IN ALL WORKING CONDITIONS

"... the most convenient method was found to be ultraviolet absorption measurement ..."



*"... all absorption spectra for this work were measured with a Unicam Quartz Spectrophotometer model SP.*500 ..."

The frequency with which the Unicam SP.500 is mentioned in the literature is convincing proof of the sustained quality of its performance and of the wide variety of applications for which it is particularly suitable. For the maintenance of standards of both raw materials and the final product, for academic and medical research, wherever there is a problem of analysis or control, the easiest, most efficient, most economical answer may well be the Unicam SP.500 Spectrophotometer.

An illustrated leaflet describing the instrument in detail will gladly be sent on request.

UNICAM

UNICAM INSTRUMENTS LTD · ARBURY WORKS · CAMBRIDGE

U124

NATURE

No. 4454 SATURDAY, MARCH 12, 1955 Vol. 175

CONTENTS

Page
Scientific Progress and Security Regulations 439

Galvani and the Discovery of 'Animal Electricity' By Dr E Ashworth Underwood 441
Adriatic Cystoceiras By Prof Lily Newton 442
Dislocation Theory By Dr W M Lomer 443
Text-book of Applied Elasticity By R E D Bishop 443

The High-pressure Cloud-chamber Cosmic-ray Programme at La Marmolada By a Joint Group from University College, London, and the University of Edinburgh 445
Design and Evaluation of Large-scale Rain-making Experiments By B J Mason 448

Obituaries
- Prof L. H Bailey By Dr G H M Lawrence 451
- Mr A Allan Gomme, M B E By H. C Miller 452

News and Views 452

Problems in Communicating Information By Prof G P Meredith 456
Health of School Children By Dr G Lapage 457
Religious and Biological Teaching 458
Indian Science Congress Forty-second Session 458
The Mass Spectroscope By S Weintroub 459
The Global Radiation in a Rayleigh Atmosphere By Diran Deirmendjian and Zdenek Sekera 459
Pituitary and Adrenal Influences on the Composition of Liver Cytoplasm By Dr E Reid 461

Letters to the Editors
- Age Measurements on a Pegmatitic Mica from the Rhodesian Shield —Dr. G D L Schreiner, Dr R T Jamieson and Dr B F J Schonland, C B E, F R S 464
- Origin of Nickel in Deep-Sea Sediments —A A Smales and Dr J D H Wiseman 464
- Snowfall and Temperature on a California Mountain —Charles L D'Ooge 465
- Newtonian Cosmology —Prof W H McCrea, F R S 466
- Infection of Wheat by Loose Smut, *Ustilago tritici* (Pers) Rostr —Dr C C V Batts 467
- Campestrin, the Antibiotic of *Psalliota campestris* —Prof S R. Bose 468
- Germination of Chlamydospores in the Endogonaceae —R M Godfrey 468
- A Polyhaploid Plant of *Solanum polytrichon* Rydb —G E Marks 469
- Heterogeneity of Date Fruits —Dr I A A Nada 469
- Imino-Acids in *Santalum* Leaves —H S McKee and G Urbach 470
- Effect of Trace Metals, Oxygen and Light on the Glucose–Glycine Browning Reaction —G S Bohart and John F Carson 470
- Copper–Molybdenum–Sulphate Interaction, in Induction of Hypocuprosis —K N Wynne and G L McClymont 471
- Ultra-violet Absorption Investigation of Melanins —W D Stein 472
- Metabolism of Thyroglobulin labelled with Iodine-131 —Dr Fred Brown and Dr Harold Jackson 472
- Relation of Colour Change to Moulting in Prawns —Bradley T Scheer and Marlin Ann Ray Scheer 473
- Aphid Take-off in Controlled Wind Speeds —Else Haine 474
- Formation of the Infection Bulb in *Arthrobotrys oligospora* Fresenius —Audrey M Shepherd 475
- Electron Diffraction Pattern of Mica of Various Thicknesses —Prof Tadatosi Hibi 475
- Reversible Polarographic Reduction of Niobium —D J Ferrett and G W C Milner 477
- Inefficiency of Diphenylpicrylhydrazyl as a Radical Scavenger —Dr J C Bevington 477
- Use of Triethylammonium Buffers in Ion-Exchange Chromatography and Electrophoresis —Dr Jerker Porath 478
- Preparation of Hexachlorocyc*lo*hexane with 18–20 per cent Gamma-Isomer Content —Miltiades N. Varnavas 478

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C 2
Telephone Number: Whitehall 8831. Telegrams. Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.I
Telephone Number · Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

Just out

PHYSICOCHEMICAL CALCULATIONS

by

E. A GUGGENHEIM
Professor of Chemistry, Reading

and

J. E PRUE
Lecturer in Chemistry, Reading

The book contains 171 problems based on published work in physical chemistry and chemical physics The problems are grouped according to subjects The Authors have tried to cover each field in as representative a way as possible.

XII, 491 pp 80 diagrams Price 53s ($7 00)
For U.S.A.: Interscience Publishers Inc.—New York

NORTH-HOLLAND PUBLISHING COMPANY
NIEUWE ZIJDS-VOORBURGWAL 68-70 AMSTERDAM-C HOLLAND

$$

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?
Suppliers to all Leading Universities, Public Libraries and Institutions of the World
Catalogues issued.

SELLING?
Specialists in Scientific, Technical Books and Publications of all Learned Societies.

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephone: Wel. 7948; Amb. 5991

$$

Analysis of Drugs and Chemicals

by N. EVERS & W. SMITH

Dr N Evers is editor of *Analytical Abstracts*
Mr W Smith is Chief Analyst of Messrs Allen & Hanburys Ltd

This entirely new book contains information you will find nowhere else on the following subjects physical and volumetric methods of analysis, general methods for determining specific constituents, inorganic and organic chemicals, natural compounds and their derivatives, fixed oils, fats, waxes, and soaps, volatile oils and crude drugs, miscellaneous pharmaceutical materials and galenicals Of particular interest is a chapter on the use of statistics in chemical analysis The authors' close association with the B P and B P C has enabled them to write an indispensable supplement to these works

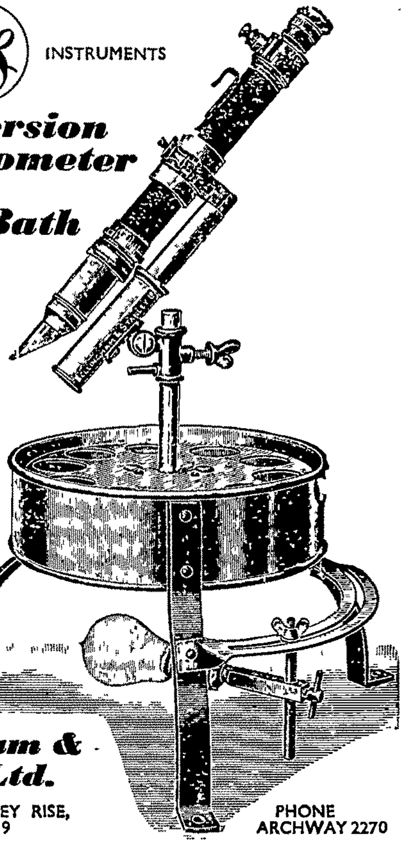
Medium Octavo 540 pages 60 shillings net

CHARLES GRIFFIN & CO. LTD
42, DRURY LANE, LONDON, W C 2

PRECISION BS INSTRUMENTS

Immersion Refractometer and Water Bath

The most suitable instrument for the accurate control of strengths of solutions having refractive indices between 1 325 and 1 367, or with additional prisms up to 1 5



Full particulars from the makers

Bellingham & Stanley Ltd.

DEPT N, 71 HORNSEY RISE,
LONDON, N 19

PHONE
ARCHWAY 2270

SCIENTIFIC PROGRESS AND SECURITY REGULATIONS

IN a recent address on "The Social Responsibility of Scientists" at the annual general meeting of the American Philosophical Society, Dr. J H. Hildebrand strongly criticized the views expressed by Prof Lewis Mumford in his paper in November 1953 on anticipations and social consequences of atomic energy Dr. Hildebrand challenged Prof Mumford's assumption that scientists have been indifferent to the social consequences of their work, and, in particular, the implication that a scientist could foresee the possible misuse of a particular discovery and refrain from making it. A scientist, he pointed out, can seldom predict just what he will discover, least of all its possible misuse in the hands of evil men Many of the most valuable discoveries have been made by chance while in search of something else, and, so far as nuclear energy is concerned, even when Chadwick discovered the neutron in 1932 there was no reason for believing that nuclei could be made to explode, and the bare possibility of releasing energy for useful purposes must have seemed a reasonable enterprise to any reasonable person The possibility of a catastrophic release of nuclear energy was revealed only in 1938 when Hahn and Meitner were searching for an artificial trans-uranium element

It is almost impossible to say, even with the aid of hindsight, at what stage this train of developments should have been stopped It might well have involved denying Norman Lockyer the use of the spectroscope with which, in 1868, he discovered helium in the sun Dr. Hildebrand argues, therefore, that it is practically impossible for the scientist to predict the moral consequences of his choice of a problem, however much he may wish to do so Not even the wisest man living can foresee all the future effects of a new fundamental discovery and correctly balance the good against the ill consequences. Apart from this, a moratorium on science could only be made effective through a moratorium on scientists. To be effective, it would have to be world-wide and would thus encounter the same difficulty as attempts at disarmament and political co-operation generally.

Dr. Hildebrand sees no hope of progress along such lines. It is neither practical nor sensible, and he agrees with Dr J Bronowski that there are no panaceas, and that the cure of the evil is to be found in a fuller understanding of both science and society Nor does he believe that either a world congress of scientists or a great assize of scientific knowledge, such as Prof Lewis Mumford suggests, would have any value He has no belief in the special competence of scientists outside their own field, and the facts are already clear enough The real problem is to get people to face the facts squarely and sensibly It is a problem in human relations, regarding which physical scientists are not particularly expert

It is also, Dr. Hildebrand adds, a matter of recognizing that, as Reinhold Niebuhr said, "there are solutions, there is no solution". Because of that, it is a problem in communication as well as in human relations, and while Dr. Hildebrand suggests that we are in error in regarding atomic bombs as the chief danger, he suggests also that the real danger is that so few of those leaving school possess both knowledge and desire for any serious intellectual pursuit. That, he submits, is the real problem, and not any alleged defect of "the scientific mind", the existence of which, like Prof A V. Hill, he denies.

Dr Hildebrand endorses Prof A V Hill's view of the social responsibility of scientists, with its humble refusal to claim any special authority or knowledge as citizens outside their professional competence, and its recognition of the common obligations of honesty, kindness, courage and tolerance It is in the light of this outlook that Dr Hildebrand's assertion that the free world will not be saved by science alone, although it would not be saved without science, should be judged We shall need, he added, every resource of knowledge and intelligence in order to remain free, and afterwards, when addressing the American Association for the Advancement of Science, he placed this insistence on the importance of a long educational process by scientists in order to dispel public misconceptions about them and the way they work, more specifically in the context of security.

Scientists have not been too successful in making themselves and their work understood by the public, and it is because of this that, as Dr Hildebrand pointed out, one of the many needs of to-day is to make it clearly understood that there are no long-term secrets in science Like Prof H. S. Commager and Prof W Gellhorn, Dr Hildebrand insists that positive achievement and progress, not the negative policy of restriction and security, provide the only firm basis of security. Once the implications of security are clearly understood, there is little risk that public support will be forthcoming for any policy which, by endangering the freedom of investigation, discussion and communication in science, endangers also the free world itself

As Dr Vannevar Bush insisted at the same meeting, in seeking to end the present distrust, scientists are not seeking special privilege, indeed, the statement issued last December by the American Association for the Advancement of Science, while criticizing existing procedures on loyalty and security in the United States, contains proposals for strengthening the basis of national security which are of much wider interest They are at least as pertinent in Great Britain as in the United States, and it should be noted that the Association has since urged the adoption of a uniform policy by all government agencies making grants for, or otherwise supporting, unclassified research. The Association is concerned about the procedures under which scientists are judged worthy of receiving federal grants for research which does not involve problems of national security, and it recommends specifically the general adoption of the policy by which the National Science Foundation determines its awards. Under that policy, appraisal of the merit of a proposal is based on the experience, competence and integrity of the investigator, as judged by a panel of competent scientists who have a working knowledge of his qualifications The Foundation does not, however, knowingly make or continue grants to a person who is an avowed Communist, or has been established as such through judicial proceedings, or to anyone who avowedly advocates change in the government of the United States other than by constitutional means, or who has been convicted of sabotage, espionage or similar crime involving national security.

The statement issued by the American Association for the Advancement of Science gives a constructive analysis of the policies on which the security-screening programme of the United States is based. It accepts frankly both the necessity for such a programme at the present time, and also that examination of the character of persons likely to be entrusted with vital information must go beyond a determination of loyalty. It was that second point which provoked the sharpest discussion in the debates last year on the Atomic Energy Authority Bill in Great Britain. A person may be of unquestioned loyalty and still be a risk if he is given access to vital information. The statement also points out that the security programme is for the protection of the whole nation and that, although scientists may be specially interested, because of the intimate dependence of military strength upon scientific progress, the welfare of the nation as a whole must be the controlling factor, and not the interests of an individual or the welfare of a particular group. The policies, moreover, must be comprehensive and their application impartial.

The statement, however, derives much of its general interest from its more extended discussion of a further point which has received much less attention and the implications of which require wider consideration they should not have been overlooked in the recent discussions of the Commonwealth Prime Ministers on atomic and thermonuclear energy. Security-screening programmes are a means to an end, not an end in themselves. Their role in defence policy is negative rather than positive They may deprive a potential enemy, at any rate temporarily, of information about armed forces or the development of new weapons, but they create no new weapons themselves The degree of secrecy, the conditions under which secrecy is desirable, and the risk of losing secrecy have all to be considered in terms of their contribution to the development and maintenance of the military, industrial and moral strength which are a nation's ultimate protection against effective attack.

What has now to be recognized is that, with the essential dependence to-day of military strength upon science, the security practices used in the past to safeguard military information are no longer fully valid. Scientific knowledge cannot be kept secret by such means Progress in science is a cumulative process in which each scientist builds upon what is known, and national boundaries and security systems cannot contain this process of extending knowledge without so discouraging the spirit of inquiry that the state of learning and of technology as well as the rate of scientific progress are adversely affected. At best, among advanced nations, security measures can provide an advantage of time there is no such thing as a permanent scientific secret.

When this is recognized, the American Association for the Advancement of Science points out, the whole picture changes. Since security demands superiority in science, the first consideration for security is to provide the most favourable circumstances for the advancement of science—an environment that will foster a healthier, more imaginative and more energetic development than that which serves enemies of freedom. The Association does not fail to recognize that there is a proper part for secrecy to play, but, by boldly challenging the current negative conception of security, it directs attention to the important but neglected questions which have to be asked if a positive programme of national security is to be developed, while keeping ahead of potential enemies in fundamental knowledge and in its application

Such a programme would ask first how best national progress can be assisted rather than how the danger of leaks can be avoided, and would be more concerned to make the most of our advantages than to minimize losses Where it becomes necessary to ask what security risk is incurred in employing a particular person, the no less vital questions of risk of delayed progress or diminished achievement incurred in not employing him must also be considered In practice, little consideration has been given to the potential gains that may accrue if the risk is taken.

So far as the United States is concerned, Dr E. U. Condon's recent decision to abandon his fight for security clearance because he feels there is no possibility of securing a fair and independent judgment at the present time, affords strong support for the Association's view. In announcing his decision and his resignation as director of research of the Corning Glass Works, Dr. Condon said that the long-drawn-out clearance difficulties had begun to affect his ability to perform his duties efficiently and even to impair his health. The case is worth noting as an example of the strained relations between the Government and scientists in the United States, and of the demoralizing effects on the scientific community over which Dr Vannevar Bush and others have expressed their concern.

Two specific changes are proposed by the American Association for the Advancement of Science First, it suggests that greater weight should be given to a man's potential contributions In any given position, greater risks can clearly be afforded if there is a large potential gain rather than only a small one. It is admitted that there would be difficulties in determining and weighing the positive factors to be considered, but the Association suggests that scientists would welcome the opportunity of co-operating in developing appropriate standards and decisions. Less difficulty, however, is attached to the second proposal, namely, that the risk should be measured with more regard to the nature of the work to be done No satisfactory procedure has yet been advanced, it is pointed out, for screening persons engaged in unclassified research by standards appropriate for screening those who have access to details of war plans or advanced weapons. But in unclassified research, the primary question is loyalty, and while neither public opinion nor the opinion of scientists would be likely to endorse the supply of public funds to a scientist of demonstrated disloyalty, that is a different matter from a security risk. Stringent security precautions are appropriate only when the information to be guarded justifies the stringency.

Adoption of these two suggestions consorts with the encouragement of free interchange of ideas and information, on which fundamental research thrives, and the Association's statement points out how such free discussion contributes to advance in technology both for peaceful and for military purposes. The positive policy advocated would encourage the interchange of scientific information and would endeavour to use as much high ability as possible, even if not all such ability could be safely used in the more sensitive positions. The Association points to the uncounted costs of the negative policy hitherto pursued, and claims that a positive policy, while admittedly demanding boldness, would eliminate such losses and foster the development and effective use of the resources of knowledge, talent and enthusiasm which the United States and the free world possess It would also go far to re-establish confidence between the Government and scientists and technologists, and remove the existing distrust and frustration which present procedures engender.

GALVANI AND THE DISCOVERY OF 'ANIMAL ELECTRICITY'

Commentary on the Effects of Electricity on Muscular Motion

By Luigi Galvani. Translated into English by Margaret Glover Foley, with notes and a critical introduction by I Bernard Cohen, together with a facsimile of Galvani's *De Viribus Electricitatis in Motu Musculari Commentarius* (1791), and a Bibliography of the editions and translations of Galvani's book, prepared by John Farquhar Fulton and Madeline E. Stanton Pp. 176. (Norwalk, Conn. Burndy Library, 1953) n p.

GALVANI's small work on electricity and motion is one of those books which have acted as stimuli to later thought in many fields, but the contents of which are little or imperfectly known to-day. The fact that Galvani carried out experiments by which electrical stimulation caused the contraction of the severed legs of a frog will be remembered by most—though incidentally even this fact is not mentioned in some of the histories of medicine. But this simplification overlooks two fundamental points. The direct stimulation of muscles by electricity had already been widely practised, and Galvani's fundamental observation was not the result of direct stimulation.

Sir Isaac Newton had suggested as early as 1713 that an 'electric spirit' might be the cause of both sensation and of muscular motion. Caldani, who was Galvani's predecessor at Bologna, and Laghi were both experimenting on the electrical stimulation of muscles before 1760, and Albrecht von Haller was also familiar with the practice. The point at issue at this period was whether the 'animal spirits', which in the old physiology were supposed to flow in the nerves to produce sensation or muscular contraction, were indeed 'animal electricity', produced in the living body itself. In 1773, John Hunter dissected the torpedo, or stinging-ray, and an excellent account of its electric properties was published as a complementary paper by John Walsh in the same number of the *Philosophical Transactions*. By 1780 it was generally held that living muscle produced an electric charge which was discharged through the nerves. But there was no proof that this 'animal electricity' actually existed. It was about this time that Galvani started his investigations on frogs' legs. The legend says that he noticed a certain phenomenon while he was preparing frogs' legs in the kitchen for his sick wife There is no foundation for this statement, but his first observation was nevertheless, as he says himself, the result of an accident.

Galvani's initial observation was made when he was preparing the hind legs of a frog for experimental work—possibly the direct stimulation of the nerve or the muscle by electricity. What happened then is reminiscent of Roentgen's 'accidental' discovery of X-rays This is what Galvani says. "Having in mind other things, I placed the frog on the same table as an electrical machine . . . so that the animal was completely separated from and removed at a considerable distance from the machine's conductor. When one of my assistants by chance lightly applied the point of a scalpel to the inner crural nerves of the frog, suddenly all the muscles of the limbs were seen so to contract that they appeared to have fallen into violent tonic convulsions Another assistant who was present when we were performing electrical experiments thought he observed that this phenomenon occurred when a spark was discharged from the conductor of the electrical machine". Galvani repeated the experiment and carried out many others under varying conditions which need not be summarized. His conclusion was that the 'animal electricity' which is peculiar to animals is secreted mostly by the brain, and is conducted specially by the nerves A discharge of electricity from the muscle by way of the nerve stimulates the muscle fibres and results in a contraction

We would now explain the first experiment by the assumption of electrostatic induction, and on many other points Galvani was wrong. His experiments must have been spread over a long time, and it was not until 1791 that he published his "De viribus electricitatis" as an *opusculum* of fifty-five pages in the transactions of the Bologna Academy. At least one copy exists of a direct reprint of the *opusculum*, and later in 1791 there was a further reprint in which the first signature was reset. Galvani sent an inscribed copy of this rare reprint to his younger contemporary, Alessandro Volta, who in 1791 was a very distinguished scientist famous for his work on the electrophorus, on electrometers, and on atmospheric electricity. At first Volta apparently thought that Galvani had shown the existence of animal electricity, since he said in an address at Paris on May 5, 1792, that Galvani's book "contains one of those great and brilliant discoveries which deserves to mark a new era in the annals of physics and medicine". However, Galvani's somewhat unscientific approach to the subject could not long satisfy Volta, who soon experimented on his own account During this year 1792 Volta published twelve papers on galvanism In the subsequent controversy, Galvani, a modest retiring man, remained silent, and the defence of 'animal electricity' was conducted by his nephew Aldini Volta very soon became convinced that Galvani's results were due to the contact between a metal and a moist body, and the experiments based on this theory led to his discovery of the voltaic pile, the chain of cups, and the continuous current From his physiological experiments he deduced that the electrical stimulation of any nerve produces the type of action or sensation with which the nerve is normally associated. The direct sequel to this discovery was the doctrine of specific nerve energy developed by Johannes Muller.

Galvani died in 1798, and in his last years he did little to support his adherents in the battle for the cause of 'animal electricity'. Volta survived him by twenty-nine years, and his theories held the field then and long after his death It is true that in 1811 Leopoldo Nobili, using the newly invented galvanometer, detected electric currents in frogs' muscles But Nobili attributed these currents to a thermo-electric effect, and the existence of an electric current was not recognized until the publication of the work of Matteucci in 1838 This was the 'current of injury' which was investigated more fully by DuBois-Reymond

This fine facsimile edition of the Latin text of Galvani's work is due to the enthusiasm and munificence of Mr. Bern Dibner founder of the Burndy Library Galvani's Latin is not easy reading, and the accompanying English translation by Dr Foley is lively and idiomatic It is not a literal translation, but a comparison of certain passages with the original shows that it preserves the sense with accuracy. It is curious that while Galvani's book was translated into German in 1793 and again in 1794, into Italian and Russian in 1937, into French in 1939, a translation into English was not published until 1953. In that year another English translation by Prof Robert Montraville Green also appeared The present edition is enriched by a very learned and well-written introduction by Dr. I. Bernard Cohen, in which he discusses critically the state of electrical knowledge before and during the time of Galvani The work concludes with a valuable bibliography of Galvani's book by Prof John F Fulton and Miss Madeline Stanton. This is a revision of the bibliography originally published in 1936 by Prof. Fulton and Harvey Cushing E ASHWORTH UNDERWOOD

ADRIATIC CYSTOCEIRAS

Jadranske cistozire

Njihova morfologija, ekologija i razvitak By Dr. Ante Ercegović (Fauna i Flora Jadrana—Knjiga 2) Pp v+212+30 plates. (Split Institut za Oceanografiju i Ribarstvo Fnr Jugoslavije, 1952) n.p

ALTHOUGH the translucent inshore waters of the eastern Adriatic and its numerous green islets are very rich in *Cystoceira*, these plants have hitherto not been the subject of a serious systematic study, comparable with that of Valiante in the Gulf of Naples and Sauvageau at Banyuls The recent work by Ercegović is therefore of especial importance both for itself and from a comparative point of view Thoug the book is written in Croat with a description of th new species in Latin, there is a French summar (36 pp), and a French translation of the rubri of the statistical tables is given throughout th volume

A general morphological description of the genu *Cystoceira* is followed by a key to fifteen specie seven of which are described for the first time It i interesting to note that though the genus is generall considered to be hermaphrodite, unisexual individua have been recorded. A systematic account is give of each of the species mentioned in the key, and th species, together with their sub-species, are beaut fully illustrated by plates which show the essenti criteria of determination as well as the habit. Th statistical tables record the precise location of th plants, the date of collecting, depth, fertility an type This part of the work is of especial valu because its precision will enable later studies to correlated with those now published, a matter th may well prove important in a genus with such a exceptionally wide range of variability as *Cystoceir*

The second part of the book deals with th ecological study of the genus and raises many point of interest The Fucales is an order with a very wid geographical range, its main centre occurring perhap in the waters of the southern hemisphere, though i the North Atlantic its members are an importan constituent of the inshore marine flora Betwee these geographical extremes, the genus *Cystoceir* occurs in considerable quantity in the Mediterranea and Adriatic, and Ercegović points out that th genus appears to be in a state of instability He examines the great variability in the species from thre points of view dependence on external environmenta factors, adaptational value and importance in th evolution of new forms Great care has been take to study the first of these in relation to six species in all of which a study has been made of the rang of form of different populations and also the variability within a population.

In considering the possible adaptational value o the variation, Ercegović discusses first the effect o the substratum and the effect of variation in wate temperature. This latter is of great importance i the Adriatic, which has a considerable temperature range within a comparatively small area. An inte esting correlation is made between the growth an reproductive periods of the various species and wate temperature

Light intensity is discussed in relation to specie distribution, as is also the effect of water movement oxygenation and salinity.

The third part of the ecological section deals wit the instability of the genus in the Adriatic and th evolution of new forms Consideration is given t genetical variation, selection and ultimate isolation The author concludes from his extensive study tha *Cystoceira* is a genus of comparatively recent origin not yet completely stabilized and thus still capabl potentially of further evolution.

The size and location of the Adriatic make it a eminently suitable place for an ecological an evolutionary study of *Cystoceira*, and it is hoped tha this monograph will form the basis for further wor in the future, particularly along cytological an genetical lines. Though the collection of the plant is not facilitated by long periods of low-water as i the Atlantic, the beauty of the coast with its gree islands and crystal-clear inshore water compensate the algologist until the light fades. Then, on a clear, still night, each star sheds its 'road to the Isles' and the lights from the little sailing vessels mark the homeward journey of those islanders who have sold fruit and olive oil on the mainland quays during the day. Under such conditions can *Cystoceira* be studied in one of its most rewarding localities

LILY NEWTON

DISLOCATION THEORY

Dislocations in Crystals

By W. T. Read, Jr (International Series in Pure and Applied Physics) Pp xvii+228. (London McGraw-Hill Publishing Company, Ltd., 1953) 36*s*.

THIS book has the well-defined object of setting down the strict logic of dislocation theory, and of deriving its consequences in some special physical situations where the dislocation structure is uniquely defined by the macroscopic conditions or by direct observation. The reader the author has in mind throughout is one who is willing to make an effort to teach himself, only a modest mathematical ability is required to follow the text and many of the numerous illustrative problems.

The first four chapters introduce the geometrical properties of single dislocations, their slip and climb movements, the concepts of stacking faults, partial dislocations and 'good' and 'bad' crystals Chapter 5 gives the details of the forces on dislocations under uniform stress and is rather more mathematical. Chapters 6 and 7 are again geometrical and deal with dislocation multiplication mechanisms and the details of partial and extended dislocations in real lattices. Chapters 8 and 9 contain the mathematics of the stresses around dislocations and the forces of interaction between them, and conclude the first part of the book. The remaining five chapters deal with the application of the theory to two physical problems—crystal growth and the properties of grain boundaries In the chapters dealing with the energy and mobility of boundaries a strongly critical approach is used, so that after a careful reading and study of the problems, the reader is left with an unusually clear picture of what is required by theory, and what is merely plausible

The book is in no way concerned to introduce the reader to the whole scope of dislocation theory, and scarcely mentions such topics as the critical shear stress of single crystals, the yield-point phenomena or theories of work-hardening, recovery and polygonization. While the omission of these topics is in keeping with the policy of avoiding discussion of situations where the precise arrangement of the dislocations is unknown and important, it means that a reader wishing to master the interpretational side of dislocation theory must supplement Read's book with some other, such as Cottrell's "Dislocations and Plastic Flow in Crystals" (Oxford University Press)

There must, however, be many people concerned with plastic deformation of crystals, and having some familiarity with dislocations who feel a need for a firmer logical and mathematical basis for their knowledge This book, with its seventy or more problems and hundred references, should prove ideal for anyone prepared to read carefully and work constructively Some of the problems make more demands on the reader's mathematics than does the main text. and a few sound rather like young research programmes. They all make the reader think.

The standard of production is the usual high one expected of the McGraw-Hill monographs The text is lucid and illustrated by many well thought out diagrams The paragraph headings in the detailed contents lists are likely to prove as useful for reference purposes as is the index, though the latter is pleasantly explicit. The limited public to whom the book is addressed should be well pleased with it, those who want a general account of physical hypotheses, however successful and widely accepted they may be, must look elsewhere.

W M LOMER

TEXT-BOOK OF APPLIED ELASTICITY

Applied Elasticity

By Prof Chi-Teh Wang Pp. ix+357 (London McGraw-Hill Publishing Company, Ltd, 1953) 57*s* 6*d*

THIS book is written for "senior-graduate engineering students", it is an advanced text-book rather than a mathematical treatise on elasticity In it the author explains fundamental elasticity theory in fairly simple terms and then deals with several of the most useful analytical and numerical methods of solving problems.

The first two chapters are concise and deal with the analysis of stress and strain, all equations being given in component form in the manner of Timoshenko. Chapter 3 is concerned with stress–strain relations, and the theory is limited to that of isotropic solids; also included are short sections on strain energy, existence and uniqueness of solutions and St. Venant's principle Plane-stress and plane-strain problems, in both rectangular and polar co-ordinates, are dealt with in Chapter 4, this includes solutions for rotating disks and problems of thermal stress. Chapter 5 is devoted to torsion of prismatic bars, thin open sections, thin-walled tubes and circular shafts of variable diameter. An excellent chapter is devoted to finite difference approximations and the relaxation technique

The principles of potential and complementary energy are introduced in Chapter 7 together with a discussion in terms of the variational calculus Also included in this chapter are the Rayleigh–Ritz method, the so-called Galerkin method, the method of Biezeno and Koch, and finally the reciprocal theorem and Castigliano's theorems This is followed by a chapter on solution by means of complex variables.

The remainder of the book is concerned with problems of "Advanced Strength of Materials". It comprises four chapters which deal respectively with the bending and compression of bars and elastic stability, numerical methods for finding critical loads, the bending and buckling of thin plates, and thin shells

When the purpose of the book is borne in mind—namely, the instruction of engineers—it is apparent that the author has selected the topics of his discussion with considerable skill. For little is included that is of interest only to the mathematician. The presentation is lucid, and problems are included for the reader who wishes to test his understanding of the theory

R E D BISHOP

Diamond Technology

Production Methods for Diamond and Gem Stones. By Paul Grodzinski. Second revised and enlarged edition. Pp. xxxiv+784. (London: N.A.G. Press, Ltd., 1953.) 52s. 6d.

"DIAMOND Technology" is a completely revised and enlarged edition of Mr. P. Grodzinski's "Diamond and Gemstone Production Methods", which was published as a matter of urgent necessity soon after the start of the Second World War. The earlier volume contained 256 pages, whereas the new edition has 784—an indication of the vast increase during the past decade in the use and importance of diamond in a number of industrial processes. It is indeed fortunate for those concerned with diamond mining that, unlike the non-transparent types of other gem minerals, even impure diamonds have a considerable market value.

In his capacity as technical editor of the *Industrial Diamond Review*, Mr. Grodzinski has been in constant touch with technical advances throughout the world, and has himself contributed towards the design of new instruments, particularly in the field of hardness testing. The book is divided into two main sections, the first dealing with general manufacturing methods and the second with special methods. Thus, in the first part there is a chapter on grinding and polishing gemstones, while in the second there is a parallel chapter on polishing gemstones for jewellery, where the specific forms developed are dealt with. This is bound to lead to a certain amount of overlapping, and it is possible that by careful rearrangement the book might be reduced in size without losing anything of real value. It seems to me that an opening chapter on diamond itself, its structure, crystallography, varieties and properties, would be a useful foundation for what follows. The information given in Chapter 13, on the selection and orientation of industrial diamonds, could largely be included in such a preliminary chapter.

"Diamond Technology" is a well-produced volume, and the understanding of the text is greatly assisted by the illustrations, of which there are nearly five hundred. The industrial world should be grateful to the author and publishers for bringing together so much scattered information within the covers of a book which, by modern standards, is not unduly expensive.
B. W. ANDERSON

Der Ultraschall

Und seine Anwendung in Wissenschaft und Technik. Von Dr. Ludwig Bergmann. Sechste völlig überarbeitete und erweiterte Auflage, mit 609 Bildern. Pp. xvi+1114. (Stuttgart: S. Hirzel Verlag, 1954.) Ganzleinen, 72 D. marks.

THE appearance of a sixth edition of this well-known book is a pointer both to the expansion which ultrasonics has undergone in the past years and the success of Dr. L. Bergmann in writing on the subject. He has indeed made it his life's work to keep this treatise up to date, and workers in this field will hope that he may long live to continue it.

The first edition appeared in 1937, a slim volume of some two hundred and fifty pages and a hundred and fifty figures. Now Dr. Bergmann's offspring has grown to an unwieldy tome of eleven hundred pages and six hundred figures, while the references number more than five thousand. Since practically every reference finds its due position in the text, one cannot but marvel at the industry of the author in reading and collating all this material. It is impossible to summarize the work here, but one notes, beside the more academic aspects of ultrasonics whic occupy five chapters, others on industrial applications, medical applications and ultrasonics i Nature. No worker in ultrasonics can afford to b without this book. It is a pity that the great size o this edition makes it unlikely that a publisher will b found to translate it into English as the first editio was.
E. G. RICHARDSON

Textile Fibers, Yarns, and Fabrics

A Comparative Survey of their Behavior wit Special Reference to Wool. By Ernest R. Kaswel Pp. xvi+552. (New York: Reinhold Publishin Corporation; London: Chapman and Hall, Ltd 1953.) 88s. net.

THIS book is a very full review of the literatur of those properties of fibres, yarns and fabric which depend on fibre mechanics and the geometr of yarns and cloths. The first three chapters give comprehensive description of the mechanical prope ties of the various natural and man-made fibre Succeeding chapters discuss the friction of fibres an yarns, the moisture absorption of fibres and the effe upon fibres of heat, sunlight, weather and the commo chemical reagents. Two rather flimsy chapters o the microbiological resistance of fibres and the dyeing properties conclude this part.

The second and more valuable part of the boo deals with the properties of textile structures. Fabr resilience, drape and crease recovery are ably di cussed. The chapter on resistance to abrasion especially good, though surprisingly there is n mention of 'pilling'. A single chapter on felting an shrinkage is scarcely sufficient, but the sections on t effect on wool felting of fabric geometry and blendin with other fibres are valuable. There are usef chapters on the transmission of air, heat and moistu through cloths and on the acquisition of soil by fabr and its removal.

The author quotes at length from original paper of which more than four hundred, chiefly from Briti and American journals, are listed in the bibliograph The book is well indexed and will be welcomed b textile scientists and technologists as a compendiu of research upon the functional characteristics fibres and fabrics.
W. J. ONIONS

Annual Review of Physical Chemistry, Vol. 4

G. K. Rollefson (Editor), R. E. Powell (Associa Editor). Pp. x+493. (Stanford, Calif.: Annu Reviews, Inc., 1953.) 6 dollars.

THE present volume of this excellent revie covers twenty branches of physical chemistr written by British, Canadian and American specialist All the articles are readable and informative, and t bibliographies are international in character. Th section on micro-waves and nuclear resonance giv up-to-date information on this new field; that o experimental molecular structures will be of intere to many chemists, when read in conjunction wi that on experimental crystallography.

Although these parts of the volume have be singled out for mention, all the articles are goo and the authors have contrived to make the boo read more like a text-book than an abstract journ which is a considerable achievement when the lar amount of information contained in it is taken in account. There can be no doubt that this publicatio now in its fourth year, is filling a place in chemic literature with marked success.

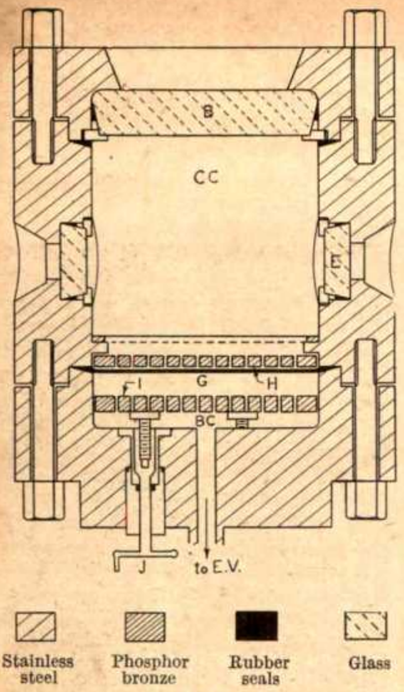


Fig. 2

their generosity in providing, without charge, electric power for the operation of the cloud chamber. We are also indebted to the construction firm of T.O.R.N.O. for assistance in the installation of the cloud chamber.

The High-pressure Cloud Chamber and its Operation

A detailed description of the cloud chamber will be published elsewhere ; but the main features of the design are illustrated in Fig. 2. The body of the chamber was constructed of stainless steel by Messrs. Brown, Bayley and Co., of Sheffield. The internal diameter is 8 in., the walls are 2¼ in. thick, and the volume of the main part *CC* of the chamber is 6 litres. The depth of the chamber is 8 in. The window *B* is of prestressed glass 1½ in. thick and the events are photographed through an aperture 3¾ in. in diameter. The illumination is provided through two similar glass windows *E*, 1⅝ in. in diameter and 1 in. thick, by Mullard *LSD*-7 photoflash tubes.

The expansion is provided by a rubber diaphragm *G* which operates between the brass plates *H*, *I*, each perforated by 600 regularly spaced holes 1/24 in. in diameter. Adjustment of the expansion ratio from outside the chamber is provided by the handle *J*, which gives a smooth axial motion to the back plate.

Initially, gas is pumped into the back chamber *BC* in sufficient quantity to force the rubber diaphragm *G* against the perforated plate *H*. Operation of the chamber is achieved by a sudden expansion of the gas in the back chamber *BC* into a third volume. This causes *G* to be pushed back suddenly against the back plate *I*.

Typical pressures in atmospheres, in the cloud chamber proper, *CC*, and the back chamber, *BC*, are listed in Table 1.

Table 1

	Cloud chamber *CC*	Back chamber *BC*
Before expansion	78	80
After expansion	73	60

The camera contains two Dallmeyer lenses of focal length 35 mm. and operates with a stereoscopic angle of 15°. An aperture $f/11$ has been used and the depth of focus is then approximately 5 cm.

Some characteristics of the operation of the chamber are set out in Table 2.

Table 2

Expansion ratio (75 atmospheres argon, alcohol)	1·06–1·07
Clearing field	2,000–4,000 V. across chamber
Recycling time	15 min.
Expansion time	0·2 sec.
Time of drop growth	0·2 sec.
Width of minimum ionization track	0·5 mm.
Sensitive time	2 sec.

The counter system used for selecting events consists of three trays of counters, one above the chamber and two below. A block of lead 15 cm. thick is placed above the top tray, and another block 5 cm. thick between the second and third trays. In a typical selection system, six-fold coincidences are required to produce an expansion of the chamber in which one counter of the top tray is discharged, any three of nine counters in the middle tray and any two of ten in the bottom tray. With such an arrangement the waiting period for an expansion is about fifteen minutes.

Interpretation of Events in High-pressure Cloud Chamber Photographs

The problem of particle identification in the high-pressure cloud chamber presents some novel features. Many of the slower particles stop in the chamber and their residual range provides an important means of identification. For example, the energies of particles just stopped in crossing one diameter of the chamber filled to a pressure of 75 atmospheres is 4·5 MeV. for electrons, 18 MeV. for μ-mesons, 20 MeV. for π-mesons, 35 MeV. for *K* mesons and 44 MeV. for protons.

Even minimum ionization tracks are continuous, and so drop-counting methods are inapplicable ; but instead, track-width measurements may be used for velocity determinations. Some information about the velocity can also be obtained from a count of the frequency of delta-rays along a track.

No magnetic field is available with the present chamber, and the only means of determining momentum is from multiple scattering. Owing to the width of the tracks, this limits the measurements to tracks for which $p\beta$ is less than 200 MeV./c. Another high-pressure cloud chamber is being built at present which will incorporate a magnetic field of 10,000 gauss. It is difficult to devise objective tests of the absence of distortion in tracks that show appreciable multiple scattering. This is being overcome to some extent by taking two sets of pictures of each event at different times after the expansion. In the measurement of events described below, it has been assumed that distortion is absent.

Results of the Operation of the Chamber

So far, three thousand photographs have been obtained during the period of operation at Marmolada. An analysis of events of interest among these shows the following.

(1) Eight V^0 particles originating in the chamber wall or in the lead around the chamber. Two of these occur in the same shower (Fig. 3) and are discussed in detail below. Four of these events are consistent with Λ^0 decays with measured *Q* values of 43^{+33}_{-13},

THE HIGH-PRESSURE CLOUD-CHAMBER COSMIC-RAY PROGRAMME AT LA MARMOLADA

By a Joint Group from University College, London, and the University of Edinburgh*

TWO widely different techniques are commonly employed in the study of the new unstable particles of the cosmic radiation: the photographic emulsion and the conventional cloud chamber operating at about atmospheric pressure. It is not always easy, however, to correlate the results of observations made using the two techniques. This difficulty arises basically from the great difference in density of matter in the two devices, which varies from 0·0018 gm. cm.$^{-3}$ in an atmospheric pressure cloud chamber to 4 gm. cm.$^{-3}$ in a nuclear photographic emulsion.

This gap may be bridged to some extent by operating a cloud chamber under conditions of high pressure. For example, the density of gas in a cloud chamber operating at a pressure of 75 atmospheres in argon is 0·134 gm. cm.$^{-3}$.

High-pressure cloud chambers have been described at various times in the literature, but they have not so far been operated very extensively at high altitude; a high-pressure cloud chamber was operated by Valley on Mt. Evans in September 1948 (*Phys. Rev.*, **75**, 201; 1949), and more recently one has been operated by Kusumoto *et al.* (*Phys. Rev.*, **90**, 998; 1953) on Mt. Norikura in Japan in the summer of 1951). A cloud chamber based on a design of the late Prof. E. J. Williams has been operated at sea-level at Aberystwyth by Dr. G. R. Evans for some years since 1939, and a further chamber, based on a development of this design, has been operated in conjunction with the Harwell cyclotron by a group from University College, London, which has been investigating the scattering of 150-MeV. protons in deuterium.

Last summer, Dr. Evans's cloud chamber was set up at the University of Padua Cosmic Ray Laboratory on La Marmolada in the Dolomites at an altitude of 2,020 metres, and has now been in continuous operation for a period of fifteen months by a joint team from University College, London, and the University of Edinburgh. We appreciate very much the courtesy and generosity of Profs. A. Rostagni and A. Loria, of the University of Padua, who have provided space for this investigation in their laboratory and who have been of great assistance in arranging for the importation of the equipment into Italy and its transport to Marmolada. We are indebted to the Società Adriatica di Elettricità and its staff at Marmolada, particularly to Dr. M. Pancini, for their invaluable assistance in the erection of the apparatus and in innumerable other ways and for

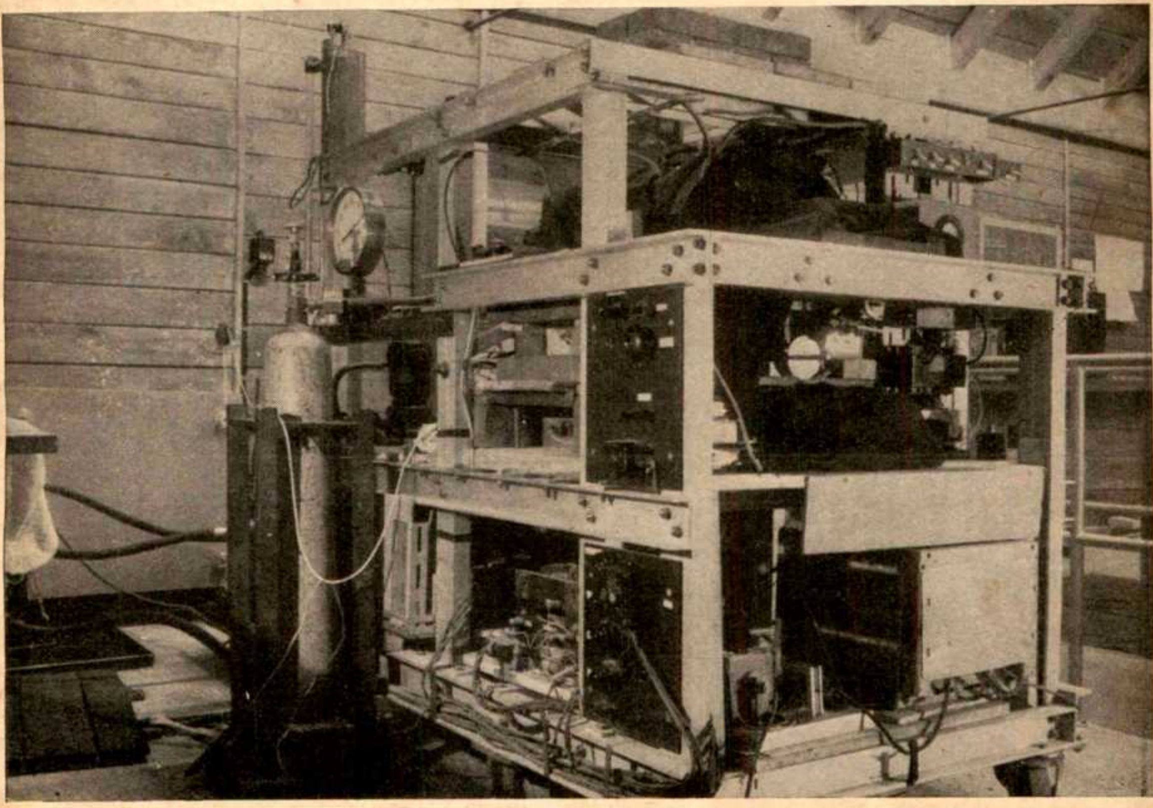


Fig. 1. General view of the cloud chamber with control gear

---

* The following physicists are associated with the planning and operation of this project. From University College, London: J. P. Astbury, P. Baxter, Dr. E. H. S. Burhop, Prof. H. S. W. Massey, F.R.S., A. J. Metheringham, Dr. N. Morris, F. R. Stannard and H. S. Tomlinson; from the University of Edinburgh: Dr. G. R. Evans and E. J. Williams.

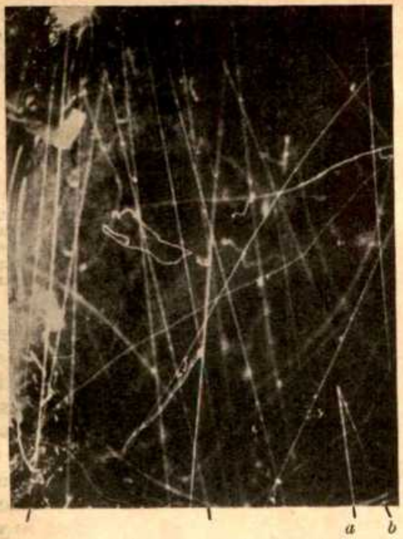


Fig. 3. Two V^0-particles, marked by tags at the foot of the photograph, produced in the same shower

52^{+35}_{-15}, 38^{+17}_{-10}, and 44^{+30}_{-13} MeV. These values depend on estimates of $p\beta$ obtained using multiple scattering, and they assume the absence of distortion.

(2) One V^0 particle originating in a nuclear interaction in the gas (Fig. 4).

(3) Five particles that come to rest in the chamber produce subsequent decays. Range and multiple-scattering measurements give for one of these particles a mass of $1{,}450^{+800}_{-450}\, m_e$.

(4) There are about sixty examples of deflexions or decays in flight of penetrating particles. With the high-pressure chamber, the vast majority of these events are likely to be deflexions.

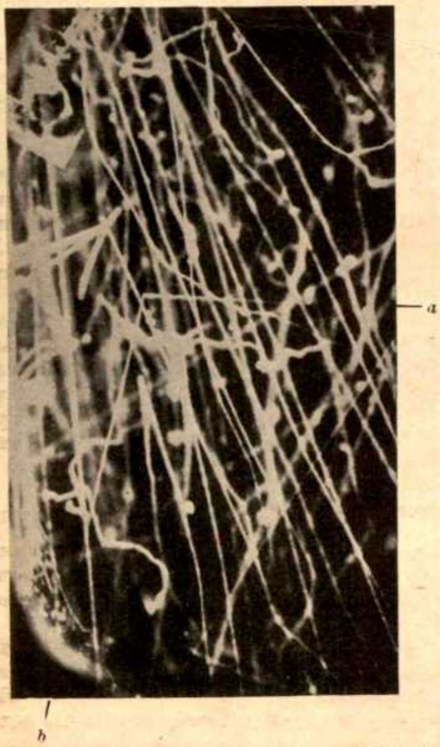


Fig. 4. V^0-particle coming from a star in the gas of the chamber

(5) Twenty particles that come to rest in the chamber without producing charged decay products have been identified as protons from range – multiple scattering measurements. Combining the individual mass values for these particles gives a mass of $1{,}750 \pm 190 m_e$.

(6) There are forty nuclear interactions in the gas. One particularly energetic star is shown in Fig. 5.

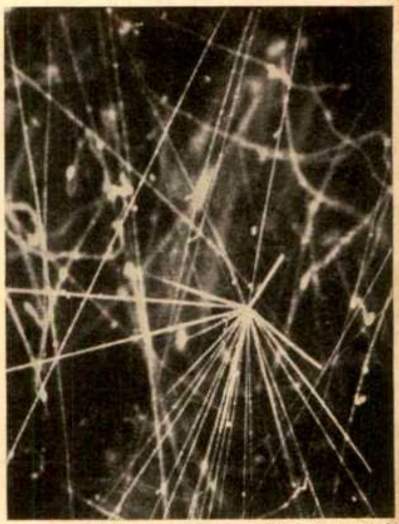


Fig. 5. A charged primary produces a 23-prong star in the gas of the chamber

Figs. 3–5 illustrate some of the more striking events that have so far been photographed.

Fig. 3 shows two V^0 events accompanying a local penetrating shower produced in the wall of the chamber. The source of the shower in the chamber wall can be located to within 1 mm., and the co-planarity of the two V's with this source can be established to better than 1°.

Unfortunately, the left-hand V has very poor-quality tracks, due to the event being out of focus. However, from a consideration of the angles, we find that if the event were a Λ^0 decay, the proton should have stopped in the chamber, whereas both tracks pass out of the chamber and appear to be those of quite fast particles.

We conclude, therefore, that the left-hand V is not a Λ^0, but is consistent with a θ^0 decay.

For the other V, assuming arm a to be a π-meson, it will have an energy of 15 MeV. for either the Λ^0 or θ^0 interpretation, while the corresponding values of $p\beta$ for arm b will be 500 MeV./c. and 800 MeV./c. respectively. Both these values are too high for our multiple-scattering techniques, and either would be consistent with the observed absence of multiple scattering. However, width measurements on arm b show that it could not be a π-meson with $p\beta$ of 800 MeV./c. We therefore conclude that this V event is not a θ^0 decay.

Fig. 4 shows a V^0 event associated with a star produced in the gas of the chamber. This low-energy star, which has a neutral primary, occurs in a local penetrating shower and has six prongs. The angle between the arms of the V is 88°. Since the projection of arm a on the film is very nearly parallel to the line joining the lenses of the camera, it is difficult to determine the orientation in space of arm a, and co-planarity of the V with the star can only be established to within 10°. There are, however, no other obvious origins for the V^0. Consideration of angles rules out completely the interpretation of the event as a Λ^0, for if such were the case, arm *a* would be the proton and would have stopped in the gas in 1·5 cm., compared with its observed length of 6 cm., before passing out of the illumination.

Multiple-scattering measurements give $p\beta$'s of 300 MeV./c. and 200 MeV./c. for the two arms. It is difficult to gauge the accuracy of these results as the scattering is very small at these values. However, the transverse momenta are 205 and 175 MeV. respectively, and check satisfactorily; and the Q value comes out to be ~ 200 MeV. The errors in the Q value will be of the order of ± 100 MeV.

The most one can say, therefore, is that the event is consistent with a θ^0 and could not possibly be a Λ^0 of Q value 37 MeV.

Fig. 5 shows a star of twenty-three prongs produced in the gas of the chamber by a charged primary. There are twelve tracks of minimum ionization; but their apparent association in pairs is not borne out when the event is reprojected in space. Of the four tracks that stop in the gas, two at least appear to be α-particles. Assuming the event represents the break-up of an argon nucleus, at least six of the minimum ionization tracks must be mesons and the energy of the incident particle must exceed 2,000 MeV.

We are indebted to the Department of Scientific and Industrial Research for the award of a Special Development Grant which has helped to finance this project, and for the award of maintenance grants to several of the research workers associated with it (A. J. M., F. R. S.). We also wish to thank the University of London Central Research Fund for the award of grants for travelling and maintenance expenses of others (P. B., E. H. S. B.). One of us (P. B.) is indebted to the Ministry of Education for the award of an F.E.T.S. Grant. We wish also to thank the Government Grant Committee of the Royal Society for an award to one of us (G. R. E.) which enabled the construction of the chamber.

DESIGN AND EVALUATION OF LARGE-SCALE RAIN-MAKING EXPERIMENTS

By B. J. MASON

Imperial College of Science and Technology, London

THE demonstration in recent years that suitable clouds may be made to precipitate by the introduction of artificial nuclei and the possibility of extending the techniques to produce economically important increases in rainfall has created the greatest interest and controversy. This is certainly an exciting new development in atmospheric physics, and, whatever may be the ultimate consequences, it has given a new impetus to researches on the fundamental physics of clouds and precipitation. The purpose of this article is to discuss the present scientific status of rain-making experiments, the fundamental problems which they pose, and what will be involved in the proper execution and evaluation of a large-scale trial with reference to conditions in Great Britain.

Physical Basis of Cloud Seeding

The observational and theoretical studies of the past few years have thrown much light on the nature of the physical processes responsible for the release of precipitation from clouds. It is now fairly well established that in widespread layer-cloud systems the dominant mechanism involves the growth of ice crystals in the supercooled region of the cloud, their aggregation to form snowflakes and, below the 0° C. isotherm, the melting of the latter to form raindrops. In non-supercooled layer clouds, which are generally rather thin, coalescences between water droplets of different sizes and speeds of falling may give rise to drizzle or, perhaps, very light rain. In shower (cumulus) clouds the relatively strong upcurrents and high concentrations of liquid water favour the coalescence process so that, in warm weather, showers may fall from clouds which are wholly below the 0° C. isotherm.

Rain-making experiments are therefore based on three main assumptions: that the presence of either ice crystals or comparatively large water droplets (to initiate the coalescence process) is essential to the natural release of rain from clouds; that some clouds precipitate inefficiently, or not at all, because these agents are naturally deficient; that this deficiency can be remedied by 'seeding' the clouds artificially with either 'dry ice' or silver iodide to produce ice crystals, or by introducing water droplets or large hygroscopic nuclei.

There is no doubt that the introduction of these seeding agents into suitable clouds is often followed by observable effects. It has been shown beyond all reasonable doubt that cumulus clouds in a suitable state of development can be induced to rain by seeding them with 'dry ice' from aircraft when similar unseeded clouds in the neighbourhood do not precipitate. The spraying of water droplets or large hygroscopic nuclei from aircraft promises to be an efficient method of releasing showers from warm cumulus clouds, and some interesting trials have recently been made in East Africa[1] with balloon-borne bombs containing gunpowder mixed with either silver iodide or finely ground salt. These experiments on individual, isolated clouds are of considerable scientific interest and may well throw new light on the precipitation mechanisms and their control by the large-scale features of cloud development. They are, however, unlikely to tell us very much about the possibilities of modifying the rainfall from widespread cloud systems extending over thousands of square miles.

Status of Large-scale Trials

For experiments on a large scale, it becomes uneconomic to disperse the seeding agent from aircraft, and the general practice is to release silver iodide in the form of a smoke from the ground, relying on the air currents to carry it up into the supercooled regions of the cloud mass. Trials of this type have been carried out on a large scale during the past six years, mainly in the United States, Canada and South America, by commercial operators.

The general procedure is to set up silver iodide generators at intervals of about ten miles along a line roughly perpendicular to the prevailing wind and to switch these on when the arrival of suitable storms in the target area is imminent. Seeding is generally continued during the passage of the storm, the working hypothesis being that seeding may cause an increase in the precipitation over that which would fall naturally. Two types of generator are in common use. In one, a 2 per cent solution of silver iodide in acetone is atomized in a propane or butane flame, silver iodide being vaporized at the rate of about 0 1 gm./min. to give about 10^{12} particles per second. In a second type, coke nuts impregnated with the silver iodide solution are burned in a crucible furnace, the normal output being about 10^{13} particles per second.

In the evaluation of these trials, the commercial operators usually adopt one of two techniques. In the 'percentage of normal' method, the rainfall at each station in the target area during seeding is expressed as a percentage of the historical average for that station—generally on a monthly basis. Maps are then drawn showing isopleths of rainfall expressed as a percentage of the monthly normal. This method may give highly spurious results since natural precipitation for a month, or any relatively short period of time, is invariably either above or below the average taken over some longer period, in other words, the weather is so variable that the climatic normal rarely occurs. It must also be remembered that commercial operators only seed under conditions favourable for precipitation, and therefore rainfall above average during a wet month is highly probable with or without seeding activities.

In the other method, the operator chooses an adjacent control region unlikely to be affected by the silver iodide smoke, and the method of evaluation generally adopted is to form a regression for the rainfall in the target area on that in the control area using historical data. Knowing the rainfall occurring in the control area during the seeding operations, the regression is used for predicting that which would fall naturally in the target area, the difference between the latter and the actual amount being attributed to the effects of seeding at a level of significance determined by the scatter of the historical data about the regression line. With this method, the apparent changes due to seeding can be statistically significant only if there is a high correlation between past rainfall in the target and control areas It has the serious disadvantage that quite different estimates of the seeding effects can be made with different lengths of historical record and different sets of target and control stations used in establishing the regression, while separate regressions can apply for different types of storm. Thus, independent evaluations of a given operation have sometimes arrived at quite different conclusions. Furthermore, if the pattern of the major storms during the seeded period differs appreciably from the average long-term pattern on which the regression is based, then the latter cannot be used to predict accurately the rainfall in the target area and consequently the assessment of the trial may be most misleading. An alternative approach might be to use the rainfall per storm as the unit and to form separate regressions for storms of the same general type, taking into account the position of the storm track relative to the target and control areas. This, however, would involve a synoptic analysis of each storm and smaller statistical samples. The same objections apply to multiple regression techniques in which the daily rainfall is correlated with a number of meteorological parameters.

From the published accounts of large-scale seeding operations one can find no convincing evidence that large increases in rainfall can be produced consistently over large areas. Although it is feasible that, under suitable conditions, marginal effects of, say, 10–20 per cent may be produced, in general, operations in any one area have not been continued for a sufficiently long period and have not been designed for use with evaluation techniques sufficiently reliable and sensitive to separate effects of this magnitude from the random variations in natural rainfall.

Some Basic Physical Problems

Apart from doubts about the validity of the statistical procedures which have been used to assess massive cloud-seeding operations, they are conducted on certain assumptions which are insecurely based, as may be illustrated by our present inability to answer the following leading questions: (a) How often in a given locality, and under what conditions, are natural ice nuclei deficient and when, and in what quantities, should they be supplied artificially ? (b) When silver iodide smoke is released from the ground, does it reach the supercooled regions of the cloud ? If so, in what concentration, and how will this vary with distance from the source at these levels ? (c) For how long does silver iodide remain active as an ice-forming nucleus under specified atmospheric conditions ?

There is some observational evidence to suggest that, while the probability of precipitation falling from supercooled clouds over Europe tends to increase rather sharply when their summit temperatures are below about −12° C., an appreciable fraction of clouds do not precipitate even on reaching the −20° C. isotherm Some of these latter may fail to satisfy certain structural and dynamical requirements, but in some cases it may be that the requisite ice-forming nuclei are deficient. Ice crystals rarely appear in significant numbers in clouds which are warmer than −10° C. 'Dry ice' will produce crystals in a supercooled cloud at temperatures below −1° C, while silver iodide produces a small number of ice crystals at about −5° C. and becomes fully active below about −10° C. In order to determine when and in what concentrations artificial nuclei might be advantageously supplied, one would wish to know the optimum concentration of nuclei for the release of precipitation from a cloud system of given characteristics, and the number of natural nuclei which are active at various temperatures in the air mass. This implies that measurements of the ice-nucleus spectrum should be made at various levels in the free atmosphere and correlated with such factors as the meteorological conditions, the origin and track of the air mass, the geography and topography of the region, the nature of the terrain and the location of possible sources of nuclei Such a programme would entail enormous labour and expense, and in view of the few measurements made with cloud chambers on aircraft which indicate that the more efficient nuclei (active at temperatures above −20° C.) occur only sporadically, it appears impracticable. In any event, because of the high degree of uncertainty involved in relating the number of ice crystals appearing in expansion—and mixing—cloud chambers to the ice-nucleus content of the free air, this method will not give reliable values of the absolute concentrations of nuclei as a function of temperature, although it may be useful in indicating whether a certain minimum concentration is exceeded, and the relative concentrations of nuclei acting at different temperatures. The problem is further complicated by the fact that the concentrations of *ice nuclei* in clear air may bear very little relation to the numbers of *ice crystals* appearing in a cloud at the same temperature, because the latter may be greatly multiplied by fragmentation.

At present, there appears to be little prospect of obtaining data from which one might predict, in a given situation, the actual requirement for artificial nuclei. One therefore has to make an intelligent guess at the minimum concentration of nuclei necessary for the rain production (probably of order 1 particle/litre), and to try to ensure that this concentration of active silver iodide nuclei is achieved at levels where they may forestall the natural ice nuclei—in general, between the $-5°$ C and $-15°$ C isotherms.

This brings us to the second problem: our present knowledge on the turbulent diffusion of particles over distances of tens or hundreds of miles is almost negligible, and its study must form an essential part of any serious investigation of the potentialities of large-scale cloud seeding. The formulæ derived by Sutton[2] for the concentration of matter downwind of a continuous source can scarcely be expected to hold for the diffusion of silver iodide particles which are required to reach heights of several thousand feet and distances of up to a hundred miles downwind. In the latter circumstances, where the plume will meander laterally in response to changes in wind direction, the wind will vary with height and time, and where vertical upcurrents may be present, it is unlikely that the theory will be valid for diffusion on this scale It is therefore necessary to appeal to experiment

Some preliminary results have been reported by Braham *et al* [3], who dispersed a cloud of tiny zinc sulphide particles from a ground generator producing some 3×10^{10} particles/sec and sampled the plume from an aircraft up to heights of 4,000 ft The particles were easily detected, since they fluoresce under ultra-violet light. In neutral equilibrium conditions, with winds of 25 m.p h, they found that the average concentration across the plume was about 100 particles/m ^{3} at a range of 25 miles and fell to the minimum detectable level (50/m ^{3}) at distances of less than 100 miles from the source. This suggests that, with a source of strength 10^{13} particles/sec, the particle concentration at these distances would have exceeded 10/litre

In some very recent experiments carried out in Australia by Smith *et al.*[4], zinc sulphide and silver iodide particles were released from the ground at the same time and place, and both were traced simultaneously from an aircraft. The measured concentrations of zinc sulphide particles at distances up to 25 miles from the generator were much the same as those obtained by Braham *et al.* when adjusted for differences in generator output The ratio of the concentration of ice crystals produced by silver iodide to the concentration of zinc sulphide particles determined at various times after release was used to measure the deterioration of the ice-nucleating properties of silver iodide.

Two types of silver iodide generator were employed, one using a hydrogen flame and the other a kerosene flame, the former producing about ten times more particles for the same consumption of silver iodide With the kerosene burner, ice nucleus concentrations of about 1/litre were detected at ranges of 20–50 km. and at heights of 1 km under neutral equilibrium conditions. With the hydrogen burner, the concentrations measured at heights of a few hundred metres fell below 1/litre at ranges greater than 10 km It is important to obtain more detailed information of this character under a variety of meteorological conditions.

The decay factor of silver iodide, defined as the ratio of the concentration of ice nuclei, active at $-17°$ C., to the concentration of zinc sulphide particles, multiplied by the ratio of the outputs of the zinc sulphide and silver iodide generators, decreased very rapidly with time of exposure to the atmosphere in the case of the hydrogen burner it decreased to a value of 0 01 after merely 16 minutes, and was less rapid in the case of the kerosene burner when the activity fell to the same value only after 100 minutes There was evidence suggesting that the decay factor of the silver iodide produced by kerosene burner after one hour of exposure to the atmosphere decreased roughly logarithmically with increasing air temperature (by about one order of magnitude for a temperature rise of 10 deg C), and this receives some support from the laboratory experiments of Bolton and Qureshi[5].

To what extent the deterioration in the ice-nucleating properties of silver iodide can be attributed directly to the influence of temperature, and to what extent photolysis of the surface layers by the ultra-violet component of the solar radiation suggested by other laboratory investigations[6] may be responsible, can be decided only after further study The decay characteristics appear to depend very much on the temperature at which the smokes are produced, the method of generation, the size of the particles, the other chemicals involved in the burning process and the nature of impurities, as well as the atmospheric conditions of temperature and humidity, the latter controlling the quantity of water vapour absorbed on the particle surfaces[7]. At present, we do not understand why silver iodide can behave as a highly efficient ice nucleus, the usual explanation which stresses similarity between the crystal structures and lattice spacings of ice and silver iodide is quite inadequate. As a first stage in the detailed study of the problem, attempts will be made at the Imperial College of Science and Technology, London, to study the oriented overgrowth of ice at low temperatures on a clean face of a single crystal of silver iodide by electron diffraction techniques Meanwhile, there remains the practical problem of discovering a method of producing large numbers of silver iodide particles which will retain their efficiency as ice nuclei under atmospheric conditions.

Suggested Design for an Experiment

Even if the fundamental problems just discussed were solved, the evaluation of large-scale seeding experiments would still be very difficult. Since we are still far from being able to compute, on a purely physical basis, how much rain will fall in a given region, the effects of seeding must necessarily be assessed statistically Since it is not possible to determine with confidence whether variations of order 10 per cent may be induced artificially by short-period trials of the type described above, there is a real need for a carefully designed experiment to be continued for a period of several years.

A line of silver iodide generators might be set up roughly perpendicular to the direction of the prevailing wind so that the target area would be a fan-shaped region downwind of the generators. The area will, of course, be rather ill-defined at the edges, while the effective range of the silver iodide will be a matter for investigation, but will probably be less than a hundred miles on most occasions. As a control area, one would choose ideally an adjacent region of similar size, shape and topography, directly upwind of the generators and in which historical records show the rainfall to have a high correlation with that of the target region There should also be a roughly uniform and similar distribution of rain-gauges in the target and control areas

In order to avoid the highly spurious results which might arise if a certain weather trend persisted during the seeded period (for example, an abnormally long, wet period), seeding should be carried out on only half the suitable occasions, the selection being made by using, say, a table of random numbers A regression can then be formed for the rainfall per storm for the target stations on that for the control stations, using the historical records for a large number of past storms of the same general type. This regression is then used to predict the rainfall to be expected naturally in the target area on the occasions of seeding, knowing that in the control region The difference between the actual and predicted values of the rainfall in the target area may be attributed to seeding at a significance level evaluated by carrying out the same procedure on the non-seeded occasions, when the differences between predicted and observed rainfall may be attributed to natural variations If it should prove impracticable to find a suitable control area, the unseeded days may be used as the only control, but the uncertainty in the evaluation will then be greater Further refinements could be introduced, such as sub-dividing the target area and performing a separate analysis for each part, using more than one control region, and using more than one meteorological parameter in forming the target-control relationships Whether these will be necessary will depend on the magnitude of the effects to be sought compared with the natural variations, the number of trials, and the level of significance judged to be acceptable

In practice it will, no doubt, be very difficult to meet all the requirements of the idealized experiment, and each region will present its own peculiar problems For these reasons, it would appear sensible, before starting field trials, to conduct a mock experiment on paper using past data The idea would be to imagine that certain past storms (selected at random) were seeded and to go through the whole operation and evaluation procedures, knowing that no silver iodide was, in fact, dispersed In this way, one could investigate the natural variability of rainfall, the adequacy of the rain-gauge networks, and the relative merits of various target and control areas, and estimate for how long the experiment would have to run in order to produce a statistically acceptable result

It is expected that experiments of this general pattern together with an intensive study of related problems will be started in Britain during the present year. There are, however, many difficulties to be faced, and a clear-cut result cannot be expected within a short time.

[1] Davies, D A , *Nature*, 167, 614 (1951) , 169, 1001 (1952)

[2] Sutton, O G , *Quart J Roy Met Soc* , 73, 426 (1947)

[3] Braham, R R , Seely, B K , and Crozier, W D , *Trans Amer Geophys Union*, 33, 825 (1952)

[4] Smith, E J , Seely, B K , and Hefferman, K J (private communication, 1955)

[5] Bolton, J G , and Qureshi, N A , *Bull Amer Met Soc* , 35, 395 (1954)

[6] Reynolds, S E , Hume, W , Vonnegut, B , and Schaefer, V J , *Bull Amer Met Soc* , 32, 47 (1951) Inn, E C Y , *ibid* , 32, 133 (1951) Vonnegut, B , and Neubauer, R , *ibid* , 32, 356 (1951) Reynolds, S E , Hume, W , and McWhirter, M , *ibid* , 33, 26 (1952)

[7] Birstein, S J , *Bull Amer Met Soc* , 33, 431 (1952)

OBITUARIES

Prof L. H. Bailey

On Christmas evening, 1954, death came to one of America's great men, the venerable Liberty Hyde Bailey, then ninety-six years of age Most great men can be classified by the profession or field of activity whereby they achieved their greatness , not so with Liberty Hyde Bailey, for his greatness is due to his manifold contributions produced almost concurrently in many fields To some persons, his renown is as a botanist, explorer and horticulturist , to others as an educator, administrator and rural sociologist , to a third group as an editor, lecturer and writer , while still a fourth group knows him best as a poet, philosopher and counsellor He was all these things, and, moreover, he was a man of forceful character, personality and energy A most excellent obituary of him appeared in *The Times* for January 11, 1955. A well-documented chronicle of his work in all fields, of his honours, and a bibliography of his seventy-odd books is to be found in *Baileya* (**3**, 26–40) (in the press).

Bailey was born and raised on a fruit farm in Michigan He was precocious as a youth, read Darwin's "On the Origin of Species" when twelve years old, and stood at the top of his class when in college His first book, "Talks Afield", published when he was twenty-eight years old, was a general botany written for the amateur This book followed his studies and work at Harvard under Asa Gray

Although Bailey wrote thirty-eight different books in the field of horticulture and agriculture, his greatest contribution was not to the field's literature, but to the reshaping of its character as an applied science He initiated what later was recognized as a revolution of methods in agricultural teaching and research This he did by execution of two dicta (1) that both the student and the faculty member participate in laboratory exercises organized as an integral part of every course , (2) that agricultural subjects of a biological nature be based on sound scientific principles, experimentation and evidence These changes in approach, from a situation where the professor had been held as above participating with his students, and from a situation where agriculture and horticulture had been viewed as crafts to be mastered by the apprentice, required years to effect Bailey and his supporters raised the academic standing in these subjects in the American university to a level where for the past quarter-century or more they have been accepted on a par with technological training in engineering

A third contribution by Bailey was his determination to carry the college of agriculture to the farm and not to restrict its facilities to the student in residence This expansion was accomplished by establishment of extension courses and assignment of workers to travel throughout New York State to assist and counsel the rural people

Bailey has been known in recent decades for his botanical work, especially that with the palms and the bramble fruits In 1892 he published his study of type specimens of *Carex* species examined and photographed by him in the leading herbaria of Great Britain and the Continent His studies of the American Carices (1883–1900) comprise eighteen papers—some monographic in scope. Taxonomic studies again received his attention from 1923 to 1949, when he commenced serious study on the systematics of the palms, the cucurbits, *Vitis*, *Rubus*, *Brassica* and others. During this time he published more than a hundred systematic papers. In this quarter-century he acquired fame as a traveller and plant explorer, and in 1949—at the age of ninety-one—visited and collected palms on nine islands of the Lesser Antilles and Tobago. Despite repeated urging, Bailey never wrote of his travels, but preferred to devote his efforts to new research.

By 1935 his private herbarium of 125,000 specimens and library of 3,000 volumes reached proportions beyond his ability to maintain and perpetuate. He and Mrs. Bailey gave them to Cornell University as the Liberty Hyde Bailey Hortorium, an institution devoted to studies on the systematics of cultivated plants. Earlier Bailey edited three encyclopædic works, of which his best known is the "Standard Cyclopedia of American Horticulture", and he has since provided botanists and horticulturists with his well-known "Manual of Cultivated Plants", the dictionary of gardening "Hortus", and its better-known successor, "Hortus Second".

Liberty Hyde Bailey was a great driving force, a rugged individualist who ruthlessly cut impeding fetters of regimentation and bureaucracy, and a man who had the capacity to develop his visions into reality. Basically, he was a humanist, always considerate of his fellow man, and of his improvement by a better knowledge and use of that which is science. He could be, and on occasion was, an egoist, a man of quick decision and action, intolerant of delay or procrastination, and one who often saw the significance of the result before considering the cost of the achievement. At the same time, he was poetically and philosophically æsthetic, sensitive to the finer qualities of life, and a man who lived a life of high personal integrity.

G. H. M. Lawrence

Mr. A. Allan Gomme, M.B.E.

Arthur Allan Gomme was born on July 15, 1882, the son of Sir Laurence Gomme, who was Clerk to the London County Council and a well-known authority on the history of London. He was educated at the Mercers School and City and Guilds Institute, where he gained his associateship. On March 1, 1904, he entered the Patent Office as an assistant examiner, and was promoted to the post of librarian of the Patent Office Library in 1920, a position which he held until his retirement from the Civil Service on April 30, 1944. He served in France in the 20th Battalion Royal Fusiliers (the University and Public Schools Battalion) during the First World War and in the Home Guard in the Second; he was made M.B.E. in 1929.

Besides being a most able and distinguished librarian in the Patent Office, Mr. Gomme did great service generally in assisting in the task of making scientific and technical information readily available to research and industrial bodies. He took a leading part in the compilation of "A World List of Scientific Periodicals", and the prefaces to the first, second and third editions of the section covering 'International Congresses' pay warm tribute to his labours. Indeed, the preface to the third edition, 1952, mentions him as a member of the council of management of the "World List" since 1935, and describes him as well known in London as an expert technical bibliographer; and it is remarked that, as well as giving the editor much sound advice, he voluntarily undertook to deal with the small but difficult section 'International Congresses'. Mr. Gomme served for thirty years as a member of the council of the Newcomen Society for the Study of the History of Engineering and Technology and was a frequent contributor to the *Transactions* of the Society. He was the author of "Patents of Invention; Origin and Growth of the Patent System in Great Britain", published in 1946.

Gomme was of a most pleasant and kindly nature, combining scholarship with courtesy. His patient assistance to all users of the Patent Office Library, whether they happened to be members of the Patent Office staff or members of the public, was very much appreciated and set a very high standard for his successors. All inquiries, from the most simple to the most academic, received the same earnest and complete attention from him. He effected considerable reorganization and rearrangement of the large collection of technical and scientific periodicals in the Patent Office Library to facilitate the work of those using it, and was always ready to listen to suggestions for increasing its scope and efficiency. Technical library circles, in which he had become a leading figure, and the Newcomen Society have sustained a great loss in his death.

H. C. Miller

NEWS and VIEWS

Chemistry at Oxford.

Sir Robert Robinson, O.M., F.R.S.

Sir Robert Robinson's retirement this summer from the Waynflete professorship of chemistry in the University of Oxford will mark the departure from active academic duties of the organic chemist who has been for many years the international leader of his science. Besides honours—the Order of Merit and the Nobel Prize—duties, such as the presidency of the Royal Society, have been so much thrust upon him that the amount of outstanding scientific research that he has still been able to direct in recent years is truly amazing. Since going to Oxford in 1931, he has supervised the work of almost three hundred research students drawn from all parts of the world; in fact, his own laboratories have had much of the character of an international post-doctorate research school which has been linked but slightly with the local activities of the University.

As successor to W. H. Perkin, Sir Robert at once extended the research prominence of the Dyson Perrins Laboratory in chemistry of natural products. To active studies of alkaloids he added investigations of plant colouring matters, steroids and other topics. The elucidations of the correct structures of penicillin, strychnine and vomicine, syntheses of several of the anthocyanin pigments and of brazilin, and finally the complete synthesis of the stereochemically correct ring system of the steroids, represent but a few of the notable successes of his Oxford work. Sir Robert has always been prominent for his contributions to the electronic theory of organic chemistry. Though but few of his later publications have dealt specifically with this subject, his ingenuity in the devising of novel organic syntheses has been due to the originality of his thoughts in the application of electronic concepts in the laboratory. Undoubtedly, recent achievements of other synthetic organic chemists throughout the world depend to a very great extent upon applications of reactions first described by Sir Robert's research school, without question this will be equally evident for many years to come

Prof E R. H. Jones, F.R.S.

Prof E R H. Jones, who is to succeed Sir Robert Robinson, is at present Sir Samuel Hall professor of chemistry in the University of Manchester He will leave Manchester after a stay of eight years, during which he has contributed much to the already high reputation of its school of chemistry. His influence in the University extends far beyond the limits of his department, for his time and wise counsels have been given generously in many directions Prof. Jones is perhaps best known for his work in the acetylene field, which he began at Manchester as a Research Fellow and continued both at the Imperial College of Science and Technology, London, and again at Manchester as professor Closely allied to this work has been the synthesis of polyenes, culminating in the synthesis of vitamin A_2. He has also contributed very largely to the knowledge of the chemistry of triterpenes and steroids and was responsible for devising a synthesis of cortisone. His interests have more recently been extended to investigations of fungal products and of plant-growth hormones such as β-indolylacetonitrile His influence on chemistry has not been confined to the researches which he has directly initiated and inspired. It has also resulted from his gift for stimulating and encouraging all his colleagues, and it is in this way that he has built up in Manchester the present very active school of organic chemistry.

Fluid Mechanics in the University of Liverpool:
Dr. J. H. Preston

Dr. J. H. Preston, reader in engineering in the University of Cambridge, has been appointed to the new chair of fluid mechanics in the University of Liverpool He will develop the study of fluid mechanics in the Department of Engineering, considering applications in civil and mechanical engineering and in naval architecture Dr. Preston joined the staff of the Aerodynamics Division, National Physical Laboratory, in 1938, after some years of research at Queen Mary College, London, and at the Imperial College of Science and Technology. His work at the National Physical Laboratory was mainly on boundary layers and their effects on the behaviour of aerofoils, and on the control of boundary layers by suction through slots or through a porous surface. In 1946 Dr. Preston was appointed lecturer in aeronautics in the University of Cambridge. At Cambridge, he continued his work on the control of boundary layers by suction and on the effects of boundary layers on the characteristics of aerofoils. He also worked on secondary flow and on problems related to the control of the circulation around an aerofoil He has recently developed a method of measuring skin friction on a surface with a turbulent boundary layer, using a single pitot tube He is now working on the prediction of skin friction at high Reynolds numbers, with special reference to ship resistance

Awards of Gauss–Weber Medals

Dr. J. M. Stagg, principal deputy director, Meteorological Office, has been awarded a Gauss–Weber medal by the Academy of Science, Gottingen, "for his researches in geomagnetism, especially his discussion of the Fort Rae Polar Year (1932–3) data and the investigations arising therefrom, so furthering the aims which Gauss and Weber envisaged when they set up the Magnetic Union in 1831". The following five Continental scientists, distinguished in the fields in which Gauss and his contemporary Weber had made fundamental contributions, also received Gauss–Weber medals Prof. Walther Bauersfeld, creator of the Zeiss planetarium (astronomy), Prof John Eggert, Zurich (astrophysics), Prof. Heinz Hopf, Zurich, for contributions to differential and algebraic geometry Prof Richard Feldtkeller, Stuttgart, for electro-acoustics and electronic measuring technique, and Prof. Werner Kleen, Munich, for work on electronic valves. The presentations were made on February 19 at a ceremony in the University Hall, Gottingen, arranged by the University and the Academy of Science to commemorate the hundredth anniversary of the death of Carl Friedrich Gauss Sir Geoffrey Taylor represented the Royal Society at the ceremony The chief address in honour of Gauss and Weber was given by Dr. Richard Courant, New York

University College of Rhodesia and Nyasaland

The following appointments, the first to be made to the academic staff of the University College of Rhodesia and Nyasaland, have been announced chair of Chemistry. Dr S. H. Harper, reader in organic chemistry, King's College, University of London, chair of African Studies Dr J. C Mitchell, director of the Rhodes–Livingstone Institute, chair of English Dr. N. H MacKenzie, senior lecturer in English in the University of Natal, Librarian. Mr. D. A. Clarke, deputy librarian of the University of Leeds

Geophysical Observatory, Quetta

The Department of Advertising, Films and Publications of the Ministry of Education, Pakistan, has issued a booklet entitled "The Geophysical Observatory, Quetta a Study in Technical Assistance" (pp 35+4 plates. Karachi Ministry of Education, 1955). As explained in the preface by S. M. Sharif, educational adviser to the Ministry of Education, a project was initiated in 1950 through an agreement between the Government of Pakistan and the United Nations Educational, Scientific and Cultural Organization, whereby expert technical advice and equipment in certain aspects of geophysics, particularly in seismology, geomagnetism and atmospheric physics, would be given, four geophysicists were recruited from various countries, including Great Britain, and arrived in Pakistan during February–June 1951. Through the service rendered by these experts and the whole-hearted co-operation of the government departments concerned, the Observatory of Quetta, in the words of the Educational Adviser, "is now ranked by competent authorities to be one of the finest institutions of its kind in South East Asia". The booklet is divided into two parts, the first of which deals with development in five different phases from the creation of Pakistan in 1947 up to recent times. The fifth phase began when, having been developed by outside help, the Observatory was in a position to offer technical assistance to other countries in the Middle East and South-East Asia which require the same assistance that has been given to Pakistan. Part 2 of the booklet deals with this scheme under the heading of "Training and Research Facilities", with sections on the climate, the buildings, seismology, geomagnetism, atmospheric physics, library, workshop and drawing offices, other facilities, Observatory publications, and general. The main emphasis of the Observatory is on practical work, and the standard is suitable for graduates in physics and mathematics, and also for geologists who have studied physics and have an aptitude for experimental physics. It is suggested that external students should stay at least six months and preferably nine to twelve months. Pakistan students are accepted for long-vacation courses, and, while instruments in regular use cannot be handled by them, they will receive facilities to learn all about their care, maintenance and adjustment. Short illustrated lectures are planned to guide students in practical activities, and visits to the Geological Survey, the chrome mines and the coal-mining areas near Quetta will also be arranged.

Bell Laboratories Record

All those who are concerned with the science and practice of electrical communication should be interested in the *Bell Laboratories Record*, a well-produced and excellently illustrated monthly journal published by the Bell Telephone Laboratories, 463 West Street, New York 14. A perusal of recent issues shows that it deals with a wide variety of subjects ranging from the study of semi-conductors and the fundamental principles of television to the policy and technical problems involved in the planning and operation of a nation-wide telephone service. The December 1954 issue contains several features of interest to those concerned with some of the latest advances in radio techniques.

Ratio of Iron to Manganese in Plants

Continuing their studies on the mineral nutrition of plants, W. Leach and C. D. Taper have investigated the absorption of iron and manganese by various plant species grown in culture solutions (*Canad. J. Bot.*, 32, No. 5, 561; 1954). Dwarf kidney beans and tomatoes were grown in complete nutrient solutions containing various concentrations of iron and manganese. The ratio of iron to manganese must be within a definite range in order to avoid deficiency symptoms in the experimental plants, namely, 1·5–3·0 for dwarf beans and 0·5–5·0 for tomatoes. Concentration ratios outside the optimum range produced deficiency symptoms of one or other of these elements. Concentrations below minimum values of both elements always produced deficiency symptoms irrespective of the iron/manganese ratio in the culture solutions. An apparent antagonism between the absorption of iron and manganese was observed with both species, as also with onion. The combined amount of iron plus manganese absorbed appeared to remain constant irrespective of the ratio of iron to manganese in the culture solution.

John Innes Horticultural Institution Leaflets

Originally prepared to put the grower, the gardener and the seedsman into touch with the latest results of research, the well-known John Innes leaflets were first brought together in volume form in 1948 under the heading of "The Fruit, the Seed and the Soil". The publication was extremely successful, and, one year later, a new volume was issued containing all the original leaflets and three new ones. A third edition of the work has now been prepared in which substantial additions have been made to the leaflets dealing with growing tomatoes out of doors and sweet corn in England, while the leaflets concerned with composts, soil sterilization, raising plants in soil blocks, the fertility rules in fruit planting and making new plants by the colchicine method have been brought up to date.

Chicago Natural History Museum

On behalf of the division of birds of the Chicago Natural History Museum, Austin L. Rand and Emmet R. Blake have prepared a delightful handbook illustrating the way the bird collections are set out. These are now arranged in habitat groups, the landscapes and the birds having been brought together from points as far apart as the Bering Sea and Antarctica; areas as widely scattered as Scotland, Chicago, Indo-China, the Kalahari Desert, New Zealand and Laysan Island are also represented. The specimens and accessory materials for the thirty-two habitat groups were either collected by museum expeditions or obtained through the generosity of friends of the Museum. A green peafowl exhibit was obtained as the result of a special expedition to French Indo-China. The emperor penguins were captured by the Byrd Antarctic Expedition of 1935, while the white stork exhibit was the gift of the Polish American Chamber of Commerce, Warsaw. The book is illustrated by some fine colour and black-and-white photographs, line-drawings of distinction and a cover design of outstanding merit.

International Pharmaceutical Federation

The sixteenth general assembly of the Fédération Internationale Pharmaceutique will be held in London during September 19–23, and is being organized by the Pharmaceutical Society of Great Britain. The opening and closing sessions and the science symposia will be held in Friends House, Euston Road, where a simultaneous translation service in English, French and German will be provided; the meetings of the sections will be in the Senate House, University of London. There will be four symposia, in which invited speakers will present papers, to be followed by general discussion; the subjects of the symposia will be: the pharmacy of blood, blood products and blood substitutes; recent advances in pharmaceutical analysis; ion exchange; and tests for the sterility of pharmaceutical preparations. The secretary of the Organizing Committee is D. F. Lewis, Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: A. E. Billington (canning officer, Agricultural Department, Federation of Malaya), senior chemist, Agricultural Department, Federation of Malaya; E. R. H. Martin (agricultural officer, Antigua), agricultural officer, Jamaica; R. B. Reid (agricultural officer, Northern Rhodesia), chief agricultural officer, Northern Rhodesia; A. Jackson (chief chemist, Federation of Malaya), director of chemistry, Federation of Malaya; Tham Ah Kow (fisheries research officer, Singapore), fisheries officer, Singapore; A. J. Browning (assistant conservator of forests, Sierra Leone), senior assistant conservator of forests, Sierra Leone; H. C. M. Parr (senior scientific officer, Tanganyika), senior scientific officer, Uganda; J. MacDonald and W. N. Scott (veterinary officers, Uganda), assistant directors of veterinary services (field), Uganda; J. L. Anderson, agricultural officer, Western Region, Nigeria; D. Jordan, agricultural officer, Gambia; R. E. Taylor, fisheries officer, Somaliland Protectorate; B. Plasecki, utilization officer, Forestry Department, Gold Coast; Miss A. P. M. Lynam, records officer, Geological Survey Department, Uganda; L. C. Cronje, entomologist, Tsetse Control, Gold Coast; D. N. McNutt, entomologist, Uganda; E. H. Roberts, scientific officer (botanist), Sierra Leone; F. J. W. Hampshire, veterinary officer, Tanganyika; J. A. Armstrong, entomologist, Tanganyika.

Announcements

Prof. T. von Kármán and Sir Lawrence Bragg have been elected foreign associates of the Paris Academy of Sciences.

Dr. W. C. Osman Hill, prosector of the Zoological Society of London, has been awarded the Makdougall–Brisbane Prize for the period 1952–54 of the Royal Society of Edinburgh for his papers on marsupials and lemurs in the publications of the Society, during the period of the award, and for his notable contributions on the structure, behaviour and systematics of the primates.

Prof. H. W. Melville, Mason professor and head of the Department of Chemistry in the University of Birmingham, will deliver the sixth annual lecture of the Plastics Institute on March 15 at 6.30 p.m. in the Manchester College of Technology. He will speak on "New Kinds of Macromolecules".

Academician W. Engelhardt, professor of biochemistry in the University of Moscow, will deliver a lecture on "Biochemistry in the U.S.S.R." on March 14, at 7.30 p.m., at the Society for Cultural Relations with the U.S.S.R., 14 Kensington Square, London, W.8 (admission, 2*s.* 6*d.*; members of the Society and students, 2*s.*).

The eighth Brookhaven Symposium in Biology, sponsored annually by the Biology Department of the Brookhaven National Laboratory, Upton, N.Y., will be held during June 15–17, the subject this year being mutation. Those wishing to attend should notify Dr. R. C. King at the above address by May 21.

The Electron Microscopy Group of the Institute of Physics will hold its summer conference in the Chemistry Department of the University of Glasgow during July 5–7. Hostel accommodation must be booked by March 31, and notice of intended papers must be sent by April 30. Further information can be obtained from the honorary secretary, Dr. C. E. Challice, Wright–Fleming Institute, St. Mary's Hospital, London, W.2.

The sixth Canadian High Polymer Forum, sponsored jointly by the Chemical Institute of Canada and the National Research Council of Canada, will be held in Ridley College, St. Catherines, Ontario, during April 14–15. At a dinner to be held on the evening of the first day, Dr. R. L. Anthony, of the University of Notre Dame, will speak on "The Physicist's Approach to High Polymers". A preliminary programme and booklet of abstracts of papers are available from Dr. H. Leverne Williams, Polymer Corporation, Ltd., Sarnia, Ontario, from whom further information can be obtained.

A symposium on astronomical optics and related subjects will be held in the University of Manchester during April 19–22 under the auspices of the Department of Astronomy. The aim of the symposium is to provide a forum of discussion for certain topics of modern optical research, both theoretical and experimental, of special interest at the present time, with particular reference to subjects which have a bearing on astronomical observation. Further information can be obtained from the secretaries of the meetings, Dr. W. L. Wilcock or Dr. E. Wolf, Department of Astronomy, University, Manchester 13.

About £30 is available from the Clough Memorial Research Fund of the Edinburgh Geological Society for geological research in Scotland and the north of England (Northumberland, Durham, Cumberland, Westmorland and Yorkshire) during the period April 1955–March 1956. Applications for grants from this Fund must be sent before March 31 to the Honorary Secretary, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh 1, from whom further information can be obtained.

The Mond Nickel Fellowships Committee is offering up to five travelling fellowships, open to persons of British nationality with degree or similar qualifications, not necessarily in metallurgy, so that they can obtain wider experience and training in industrial establishments (in special circumstances, at a university) in order to make them more suitable for employment in technical and/or executive positions in British metallurgical industries. Each fellowship will occupy one full working year and will be worth £900–1,200. There are no age limits, but awards will seldom be made to persons more than thirty-five years of age. Application forms, to be completed by June 1, and further information can be obtained from the Secretary, Mond Nickel Fellowships Committee, 4 Grosvenor Gardens, London, S.W.1.

The second issue of the "Supplement" (pp. 334) to Vol. 12, Series 9 (1954), of *Il Nuovo Cimento*, containing the proceedings of the international symposium on unstable heavy particles and high-energy events in cosmic rays, held in Padua during April 12–15, 1954, has recently appeared. The issue includes sections on pi-mesons, K-mesons, charged and neutral hyperons, unstable nuclear fragments, cloud-chamber work, jets and high-energy slower particles, recommendations for the standardization of measurements in photographic emulsions, and a report on the Sardinia expedition of 1953. A limited number of copies is available to non-subscribers, and those wishing to obtain a copy (price, 300 lire plus postal charges) should write as soon as possible to Nicola Zanichelli, Editore, via Irnerio 34, Bologna, Italy.

The headquarters of the Museums Association have been moved from the Meteorological Buildings, South Kensington, London, S.W.7, to a Georgian house which the Association has purchased at 33 Fitzroy Street, London, W.1. The move was necessitated by the extensive rearrangements in connexion with the enlargement of the Imperial College of Science and Technology.

Referring to the communication entitled "Chemotherapeutic Experiments with Natural Constituents of the Body" in *Nature*, September 18, 1954, p. 555, Dr. H. Meyer-Doring states that all the mixtures (1–6) mentioned in par. 8 were ineffective except the compound cysteinylascorbic acid.

PROBLEMS IN COMMUNICATING INFORMATION

AT the present time, when communication is being examined from many theoretical points of view, an empirical discussion grounded in research seemed desirable, and the Northern Branch of the British Psychological Society, meeting at the University of Leeds on February 12, provided a suitable forum Of the five participants, all had a practical interest in communication, and between them they represented its literary, scientific, industrial and psychological aspects. All are actively engaged in research in one or other aspects of communication. The discussion never soared philosophically but was focused mainly upon the problem of transmitting scientific data and concepts, with particular emphasis upon the industrial 'consumers' of science

The symposium provided an occasion for reviewing the preliminary findings in a piece of research on "the comprehensibility of technical reports" undertaken six months ago by the Department of Psychology, University of Leeds, with a grant from the Department of Scientific and Industrial Research It should be made clear that these 'findings' are no more than first impressions concerning the nature of the problem itself—namely, the problem of easing and increasing the flow of information from the laboratory to the factory, a problem with an obvious bearing upon industrial productivity. All those who are familiar with the facts of the matter will appreciate the difficulty in finding any clear track through the maze of diverse practices, materials, documents and human attitudes in this field The discussion, here summarized, was intended primarily to indicate methods of approach Its scope is indicated by the programme the comprehension of technical literature in the factory (Miss Frances Crisp, Department of Psychology, Leeds), experimental studies of scientific vocabulary in relation to comprehension (Dr W E Flood, Department of Education, Birmingham), problems of research in reading and comprehension (Miss M. E Meek, Institute of Education, Leeds), and some methodological problems concerning the flow of information (Dr. R Harper and Prof. G. P Meredith, Department of Psychology, Leeds)

Miss Crisp confined her remarks to conditions in the wool textile industry, where for obvious geographical reasons she has done her preliminary fieldwork. This is not a 'typical' industry, but what industry is typical? It is an industry in which historical factors play a still dominant part, not only in the industry as a whole but also in individual works, a history of persistent competitiveness in which the need for a 'flow of information' is criss-crossed by habits of mutual secrecy concerning specialized bits of 'know-how' Her inquiries concerning the flow of literature showed that, while there is much wastage through indiscriminate distribution, clearly illustrated material has a way of attracting attention, sometimes unexpectedly and with beneficial results Advertising can be a valuable vehicle of information, although the reluctance of many British advertisers to state prices is a hindrance. With scientific journals the time-lag in publication is a serious brake upon the rapid transmission of information. An even more serious obstacle is the style in which many scientific papers are written Industrial readers frequently find them unduly ponderous, and would show greater interest in research if they understood more of what was written. The need for someone to play an interpretative part between the scientist and the industrial reader was a point taken up later in the symposium.

Dr Flood's contribution, while not specifically concerned with industrial readers but rather with the popularization of science, directed attention to a technique which may well have something to offer to the problem of reducing the difficulty of scientific communication to industry. His paper referred to a number of investigations on popular reading matter and scientific broadcasts in which vocabulary was revealed as a decisive factor in comprehensibility He described the method by which he and Michael West compiled their two-thousand word vocabulary, with the aid of which they were enabled to construct a dictionary of scientific terms (One may comment here that this principle of 'communication by vocabulary-control' can be appreciated only if its restriction to popular communication is borne in mind, it is clearly out of place in communication between experts) A variety of examples illustrated the process of translation, of which a brief extract must here suffice Original "The foliage is usually persistent. The leaves are linear, linear-lanceolate, acicular or squamiform and have simple venation The leaf-surface is often glabrous or lustrous". Translation in Flood–West vocabulary · "The leaves usually last for several years They are straight and narrow, thin spear-shaped, needle-shaped or scale-like and the veins are simply arranged. The surface of the leaf is often smooth or shiny".

Dr. Flood also dealt with the understanding of concepts in so far as these have an inherent difficulty independent of vocabulary, and this was a matter further explored in the next paper, by Miss Margaret Meek Here the symposium swung over to the reader's end of the communication process. While there are obvious problems in the very varying degree of actual reading skill (witness the spread of 'reading clinics' in the United States and the recent interest aroused in Great Britain), Miss Meek made it plain that comprehension, the final yield of the reading-process, demands something more than reading-skill in the current sense, and something more than a grasp of vocabulary. "As words do not have a one-to-one relationship with facts, but are dependent for their meaning not only on the context in which they occur but also on the associations they have for the reader . . . 'word-meanings' offer both an excellent way and a wholly wrong way of discovering what the reader has understood of a passage . . Comprehension is a cumulative process, a blending of the old information with the new" Miss Meek referred to the role of clues, allusions, metaphors and archaic meanings She stressed the importance of motivation, attitude and preconception She criticized the atomicity and frequent irrelevance of much of the testing of comprehension (One might here recommend examiners to pay heed.) She urged the need to penetrate successive levels of comprehension by techniques which permit the reader to show in his own terms what a passage has meant for him Here the psychological fact that reading is not an isolated cognitive activity, but an engagement of imagination and personality itself, emerged as the considered outcome of Miss Meek's researches

Dr. Harper gave a broad survey of the 'flow of information' regarded as a scientific problem, with the view of establishing the significant variables in the process. He characterized our present knowledge in this field as no more than a "natural history stage". He used the term "information" not in the current but still esoteric cybernetic sense, but simply as a "composite of facts, ideas, knowledge and techniques". Dr Harper divided the field up into (1) media and methods, (2) material or message, and (3) focal points. Under (1) he listed as four major points of inquiry use of language, size and type of groups, use of visual aids, and the scope for interaction and 'feed-back' The B B C. concept of the 'target audience' is relevant here, under the heading of size and type of groups. He indicated the need for much greater specificity of aim if communication is to be effective This applies equally to (2), that is, content of message. Under (3) he developed an interesting series of parallels between human and electronic communication while stressing the radical differences in the nature of the processes themselves, and he reminded would-be communicators of the axiom of "training within industry" that "if the worker has not learned, the teacher has not taught". He also emphasized Miss Meek's theme of the over-riding importance of attitudes and human motivation.

Prof. Meredith, in his concluding contribution to the symposium, stressed the differences rather than the parallels between human communication and communication-engineering Basically our problem concerns a relation between the man in the laboratory and the man in the factory, differing in outlook, training and mode of life, yet mutually dependent. The scientific document is a slender and inadequate link between them The man of science, if intent on his research, cannot usually make himself expert in communication techniques The industrial expert has reasons, some good, some bad, for resisting knowledge which may change his practice The advance of science must be matched by a corresponding advance in methods of communication. Improved communication demands not less but more stress on human factors. Effective communication of the basic knowledge factors—materials, properties, processes, laws, concepts, historical bases and operational prescriptions—demands at its fullest a 'six-pronged invasion force' of verbal, diagrammatic, pictorial, filmic, material and human carriers, under the command of an appropriately trained 'communications officer'.

G. P. MEREDITH

HEALTH OF SCHOOL CHILDREN

PARENTS and others interested in the welfare of children will find, in the report of the Chief Medical Officer of the Ministry of Education for the years 1952 and 1953 (H.M S O, 1954, 5s. net), much that will interest and please them. Everywhere, the report assures us, the health of the children is satisfactory. In 1953 only 2 2 per cent of the children were considered by school doctors to be in poor general condition Thanks to immunization, diphtheria is now a rare disease, and let us hope that everyone concerned, parents included, will co-operate to maintain this protection from a dreadful disease. Rickets scarcely exists, and if tetanus (lockjaw) could be also banished by similar measures, so much the better. Among children aged 5–14 suffering acute infectious diseases, about 90 per cent suffered from measles, whooping cough and scarlet fever. There has been, in recent years, a remarkable decrease in the number of deaths among children aged 5–14 from tuberculosis In 1938 the number of children of this age-group who died of this disease was 973, whereas in 1952 it was 168, and in 1953, 107. In general, the incidence of acute rheumatism has also fallen sharply during the past ten years, but there have been exceptions in certain areas, and several principal school medical officers have reported an increase, in 1952 and 1953, of the number of children with rheumatic heart disease. There were still more than a quarter of a million children with nits and lice, but the number of verminous children was, nevertheless, the smallest known in the history of the school medical service Among the other subjects discussed by the report are food poisoning in schools, middle-ear disease and that puzzling bugbear of the parent, poliomyelitis

Less reassuring is the section dealing with dental caries, which has increased, and there is strong evidence that sweet and sticky articles of diet are important causes of decay of teeth. The consumption of sugar per head of the population rose in 1946 (immediately after the War) and has continued at a higher level. It is suggested that reduction of sweet and sticky foods would reduce dental caries considerably.

The report strongly urges the retention, wherever this is possible, of handicapped children in the ordinary schools. Most of them have to go to work when they leave school and their school life should not be too sheltered. It is expected that early auditory training and the teaching of lip-reading will enable more children with defective hearing to attend ordinary schools in the future. Children with defective sight are already attending these schools more and more, and those with defective speech can be trained in them. Very severely handicapped children should not however, be educated at the expense of other children, nor should teachers be asked to bear responsibilities in this respect that may be too exacting. For handicapped children, 222 new special schools have been opened since 1945, and these accommodate 14,165 handicapped children. Among them are 30 hospital special schools, in which about 8,000 children are being taught An innovation in 1953 was the establishment, by the Diabetic Association, of three camps for diabetic children, in which these children can have a holiday with special care and diet. The British Epilepsy Association made a similar arrangement for epileptic children. An interesting chapter of the report discusses the baffling problem of asthma, on which much research is being done A limited number of asthmatic children have been sent abroad for treatment, but medical opinion is divided about the wisdom of this procedure.

The introduction of the National Health Service has not had any serious effect on the School Health Service, but its provision of 'free' service by a general practitioner may have helped to reduce the number of children who attend clinics for minor ailments. School doctors in general have reported better co-operation between the general practitioners and themselves than ever before

It is now nearly fifty years since the School Medical Service in Britain began, and it has, during that period, expanded without interruption. It has, in conjunction with improvements in the standard of living and in family and general care, very greatly improved the health and cleanliness of the children, so that it is now possible for the Service to give more attention to the needs of individual children. Everyone who is responsible for children in any way, or is otherwise interested in their welfare, will be grateful to every member of this Service, whose patience and devotion and efficiency are giving to so many a start in life that is now so much better than it was.

G Lapage

RELIGIOUS AND BIOLOGICAL TEACHING

In a short paper devoted to religious and biological teaching in schools on the origin of life and man, Dr L M J Kramer examines the divergence in educational practice between what he calls the Sunday School, biblical or religious approach to the question of life's and man's origin and the formal scientific and biological teaching about them in schools* There is always the danger of setting young minds along one of two equally undesirable paths, one materialistic or even anti-religious, and the other taking too little account of the strong appeal of science to the intellect Before this educational divergence can be reduced, an intellectually satisfying reconciliation of religion as a whole with science as a whole is necessary, and a teacher of religion, or of science, who has not made a reconciliation for himself may be ineffective as a leader of thought Whatever view we take, evolutionary biology appears as an important social factor, affecting beliefs, and beliefs often precede or condition our actions Biology teachers in particular wield a powerful social tool, and should be careful how they do so.

The relationship of evolution to religion is not a new problem There have been, however, recent developments in both evolutionary studies and cognate matters and in religious thought

In his paper, Kramer reviews some of the newer scientific work and discusses how it may affect school practices, and also attempts to follow some religious trends before suggesting ways along which a reconciliation of science, including evolution, with religion may be reached. There are, he believes, four tests which may be applied before reconciliation is achieved.

The first test is that the strong appeal of science to the reason exposes young students to two dangers One is that of becoming a prisoner of the reason, requiring material signs and practical evidence for views held in almost every department of life, even for religious beliefs The second danger, which frequently accompanies the materialistic view, is of losing the power to appreciate simple or beautiful things in Nature or the arts

Those who grow into such an extreme state of mind are bound to be superficial in their approach to the deeper problems of life Yet even those who are believers in God and sincere Christians may feel the compelling influences of intellect and reason in connexion with physical matters. The first test of a valid reconciliation must be that it shall provide an escape for prisoners of the reason and also satisfy others who are not unmindful of the appeal to their reason.

The second test of a true reconciliation is that it must be emotionally satisfying It is not infrequently found that young people mistaking the applications of science to the production of destructive weapons for the quest for truth develop a strong antipathy to the logical processes of thought by which science often achieves its ends and effects They try to ignore science and become prisoners of strong emotions. The second test of a true reconciliation is that it must provide a different route of escape from that for the intellectual prisoner—an escape from misdirected emotionalism—as well as, naturally, doing no violence to the feelings of those Christians who are not unreasoningly against all that science stands for and has attained.

---

* "Alpha and Omega" British Social Biology Council Educational Paper, No 7 (Tavistock House, London, W C 1) 1s 9d

INDIAN SCIENCE CONGRESS

FORTY-SECOND SESSION

The forty-second Indian Science Congress was held in Baroda during January 4–10 under the auspices of the Maharajah Sayajirao University of Baroda, and was opened by the Prime Minister of India, Shri Jawaharlal Nehru About five thousand people, including two thousand delegates, attended the session, and there were about sixty guests from countries outside India

At the beginning of the ceremony, Prof S. K. Mitra, president of the session, referred to the sudden death of Sir Shanti Bhatnagar, a past general president and an honorary member of the Indian Science Congress Association, and the audience stood in silence for one minute Welcoming the scientific workers and other visitors to the session, Mrs Hansa Mehta, vice-chancellor of the University of Baroda and chairman of the local reception committee, made an appeal for the application of science in the service of man so that the destructive potentiality of science could be usefully converted for doing good In his short inaugural address, Shri Jawaharlal Nehru exhorted the scientists to co-ordinate activities and render all help in framing the Second National Five-Year Plan for the improvement of the conditions of people The general president of the Association, Prof S K Mitra, emphasized in his address the need for application of modern scientific methods in the industrial sphere with the view of increasing production and making things available to consumers at cheaper prices

The scientific business of the session was carried out in thirteen different sections representing different branches of science, and twenty-nine symposia on different scientific aspects and problems were held. In all, more than a thousand papers were read The following popular lectures were given symmetry in the atomic world (Prof P A M Dirac), on the human value of scientific progress (Prof P Auger), volcanic eruptions (Prof T. Watanabe), relation of science to democracy (W Kaempffert), hæmoglobin (Prof. Linus Pauling), scientific foundation of planning in the U S S R (Academician K V. Ostrovityanov, leader of the U S S R delegation), study of India in the U S S R. (A A. Guber), scientific research in new China (Chien Tuan-Sheng, leader of the delegation of the People's

British Pharmaceutical Codex 1954

The rapid advances in medical and pharmaceutical knowledge have emphasised the need to revise the British Pharmaceutical Codex at frequent intervals

In the present revision nearly one hundred experts have collaborated on committees and subcommittees to provide an authoritative account of the chemical, physical and therapeutic properties of all drugs of importance. The book portrays the major advances that have been made in pharmaceutical chemistry and in the practice of medicine over the past five years.

PRICE 63s. (postage 1s 8d.)
Remittance with order is requested

Published by direction of the Council of the Pharmaceutical Society of Great Britain.

THE PHARMACEUTICAL PRESS
17 BLOOMSBURY SQUARE, LONDON, W C 1

THE HOUSE OF CHURCHILL

CLAYTON'S THE THEORY OF EMULSIONS AND THEIR TECHNICAL TREATMENT
Fifth Edition By C G SUMNER, Ph D, F R I C
98 illustrations 72s.

HÆMATOLOGICAL TECHNIQUE
For Medical Laboratory Technicians and Medical Students
By E M DARMADY, M A, M D, F R C P, and S G T DAVENPORT, F I M L T
4 Coloured Plates and 23 Text-figures 18s

RECENT ADVANCES IN THE STUDY OF PLANT VIRUSES
By KENNETH M SMITH, D Sc, Ph D, F R S
Second Edition 52 Illustrations 22s 6d

PRACTICAL PHYSIOLOGICAL CHEMISTRY
By P B HAWK, Ph D, BERNARD L OSER, Ph D, and W H SUMMERSON, Ph D
Thirteenth Edition 397 Illustrations, 5 Coloured Plates 85s

HISTOCHEMISTRY
Theoretical and Applied
By A G EVERSON PEARSE, M D, D C P.
110 Illustrations 60s

PREGL'S QUANTITATIVE ORGANIC MICROANALYSIS
Fifth English Edition By JULIUS GRANT, M Sc, Ph D, F R I C.
183 Illustrations 30s

CANNING TECHNOLOGY
By A J HOWARD, M A, A R I C
113 Illustrations 30s

THE MICROTOMIST'S VADE-MECUM (Bolles Lee)
Eleventh Edition Edited by J BRONTE GATENBY, M A, Ph D, D Sc, and H W BEAMS, M A, Ph D 45s

CIBA FOUNDATION VOLUMES

COLLOQUIA ON ENDOCRINOLOGY
Vol VIII The Human Adrenal Cortex
227 Illustrations *Just Ready* 55s

CHEMISTRY AND BIOLOGY OF PTERIDINES
143 Illustrations and Diagrams 42s

THE CHEMICAL STRUCTURE OF PROTEINS
49 Illustrations 25s

J. & A. CHURCHILL LTD.
104 GLOUCESTER PLACE, LONDON, W 1

Books ON PURE AND APPLIED SCIENCE

LARGE STOCK ALWAYS AVAILABLE

Many of the books reviewed or mentioned in this journal are available from stock. Foreign books not in stock obtained to order with the least possible delay.

Catalogues on application Please state interests

Scientific Lending Library

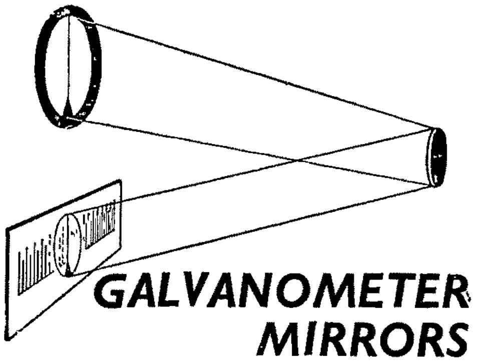
New books and latest editions obtainable promptly
ANNUAL SUBSCRIPTION,
FROM TWENTY-FIVE SHILLINGS
Prospectus free on request

Second-hand Books

Large stock of recent editions

Stationery SELECT STOCK OF SCIENTIFIC STATIONERY

H. K. LEWIS & Co. Ltd.
LONDON 136 GOWER STREET, W.C 1
Business hours —9 a m to 5 30 p m, Saturday to 1 p m
Telephone Euston 4282 (7 lines)



GALVANOMETER MIRRORS

Front surface Aluminised Glass Mirrors 0 6mm thick with radii (i.e., scale distance with conventional arrangement of lamp, mirror and scale) of 50, 100 or 200 cms., or plane, can be supplied promptly. There is no annoying double image from these front surface reflectors

Back silvered Mirrors, in which the reflecting layer is protected by the glass, are available

GOWLLANDS LTD
MORLAND ROAD, CROYDON, SURREY
Manufacturers to the distributing trade only

THE ROYAL SOCIETY

Since 1929 the Royal Society has every year reserved a number of its Ordinary Meetings for the discussion of topics of importance in science Each meeting is arranged by a Fellow of the Society who invites other leading authorities in the United Kingdom and abroad to take part A full report of each discussion is subsequently printed in the *Proceedings of the Royal Society* The titles of some recent discussions with the names of the organizers and the numbers of the *Proceedings* are printed below

V Particles and Heavy Mesons

C F. POWELL, F.R.S.
Proceedings A, Vol 221, no 1146
(13s 6d., postage 6d)

The Floor of the Atlantic Ocean

SIR EDWARD BULLARD, F.R.S.
Proceedings A, Vol. 222, no 1150
(13s. 6d., postage 6d)

The Function and Location of Enzymes in Cells

J Z YOUNG, F R S.
Proceedings B, Vol 142, no 907
(13s 6d., postage 6d.)

The First and Second Viscosities of Fluids

L ROSENHEAD, C B.E, F.R.S
Proceedings A, Vol 226, no 1164
(18s., postage 6d)

The Physiology of Man at High Altitudes

SIR BRYAN MATTHEWS, C.B E, F.R S
Proceedings B, Vol. 143, no 910
(18s, postage 6d.)

The numbers of the *Proceedings* containing reports of these discussions may be obtained from booksellers or direct from the Royal Society, Burlington House, London, W 1.

A NEW EDITION OF

DIALECTICS of NATURE

Frederick Engels

The famous work in which Marx's collaborator discussed the development and problems of the natural sciences Engels' acute analysis anticipated many later ideas

3s. *6d.*

LAWRENCE & WISHART

THE MUSEUM BOOK STORE, LTD.
25 Devonshire St., London, W.1
(Welbeck 1340)

Buy and sell Scientific Journals and Periodicals and Learned Society Publications, in all languages. Librarians, and others, should send us their list of "wants", or duplicates for sale *Binding undertaken*

● ***SPECIFIC IMMUNE SERA***

ANTI BEEF. CAT. CHICKEN. DEER. DOG. HORSE. HUMAN. PORK. RABBIT. SHEEP
(OTHERS ON REQUEST)
$12 50 per 5 cc Identifications performed Write for details

Wisconsin Alumni Research Foundation
506 N. WALNUT STREET MADISON 5 WIS., U S A

The SCIENTIFIC BOOK SUPPLY SERVICE
(T FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE: CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

MACMILLAN BOOKS

Comprehensive Inorganic Chemistry

Edited by M. CANNON SNEED, J. LEWIS MAYNARD and ROBERT C. BRASTED

Volume III—The Halogens, by ROBERT C. BRASTED

Comprehensive Inorganic Chemistry is an eleven-volume reference work on the chemical elements and their inorganic compounds. In this Third Volume the significant advances of recent years are fully reflected in a broad treatment of halogen chemistry. Both basic principles and their applications are exhaustively covered, as well as the new processes, methods of production, and the chemistry of compounds which have lately become so important 35*s.*

Fluid Dynamics of Jets

SHIH-I PAI, Ph D.

University of Maryland

Recent rapid developments in jet- and rocket-propelled missiles and aircraft has led to an increased interest in the nature of the flow field of jets. This book on fluid dynamics, while including a discussion of modern developments, thoroughly covers jet flow from fundamentals to such advanced topics as the laminar flow and the turbulent flow of compressible fluid and properties of turbulence fluctuations 37*s* 6*d.*

Minerals for Atomic Energy

ROBERT D NININGER

United States Atomic Energy Commission

This book, now published in this country for the first time, is sub-titled *A Guide to Exploration for Uranium, Thorium and Beryllium.* It is a complete handbook, covering the geology of these minerals, their incidence in America and elsewhere, their identification, the equipment to use in exploration, etc , and the evaluation of the results of successful searching 55*s*

A Text-book of Electricity and Magnetism

G. R. NOAKES, M A., F.Inst.P

This is the new, Third Edition of a book which will meet the need of those taking Intermediate degree courses and the Advanced and Scholarship Examinations of the General Certificate of Education. All the usual topics required at this stage are dealt with, and where necessary calculus is used. Among the special topics discussed are the conduction of electricity through gases, atomic physics and modern views on ferro- and terrestrial magnetism. *Third Edition.* 14*s.*

All prices are net

St. Martin's Street, London, W.C.2

Technical Books

Just Published

THE MICROTOMIST'S FORMULARY AND GUIDE

by PETER GRAY, PH D, F R M S

Med 8vo 794 pages Illustrated 65*s* net

and

IRRIGATED SOILS

Their Fertility and Management

by D. W. THORNE, Ph D., and H. B PETERSON, Ph D

Roy. 8vo. 2nd ed 392 pages Illustrated 45*s*

* * * * *

ELEMENTS OF STATISTICAL MECHANICS

by D TER HAAR

Demy 8vo. 468 pages 45*s*.

REAL FUNCTIONS

by C GOFFMAN

Demy 8vo 263 pages 30*s*. net

Based on a course of lectures on functions of a real variable delivered at the University of Oklahoma

INTRODUCTION TO MODERN ALGEBRA AND MATRIX THEORY

R A BEAUMONT and R W BALL

Demy 8vo. 331 pages 30*s*. net

ACTIVE NETWORKS

by C. V RIDEOUT

This book is intended primarily for those who have studied the physics of vacuum tubes and related devices as well as the fundamentals of the theory of passive linear networks.

Demy 8vo. 485 pages 42*s*. net

●

CONSTABLE & CO. LIMITED

10-12 ORANGE STREET, LONDON, W C.2

WANTED TO PURCHASE

Scientific books & periodicals

Entire libraries, and smaller collections; sets and runs, foreign and domestic.

WALTER J. JOHNSON, INC.

125 East 23 Street, New York, 10, N.Y., U.S.A.

Cable Address BOOKJOHNS, NEW YORK

British Office: ACADEMIC BOOKS, LTD.
129 Queensway, London, W.2

Scientific Circulations Ltd.

We have extensive stocks of Technical Journals, Periodicals and Textbooks Special terms for Technical and Commercial Libraries All Scientific and Technical publications purchased

111, Eastbourne Mews, London, W.2

Telephone AMBassador 6934

FARADAY'S ENCYCLOPEDIA
of HYDROCARBON COMPOUNDS

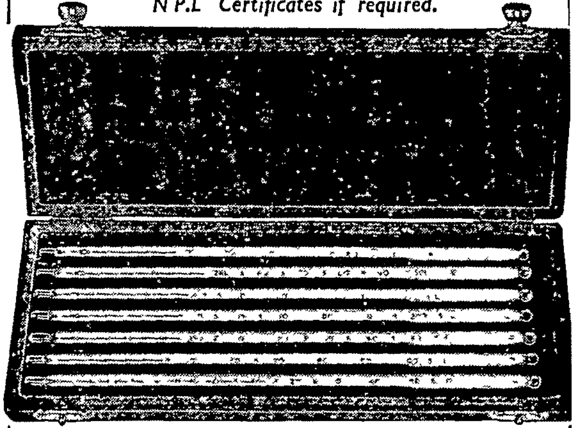
at an annual cost of less than a week's pay to a research worker gives the greatest and most up to date cover of the literature in the shortest time with the least work and produces results weeks earlier

CHEMINDEX LTD., 76 Cross Street, Manchester 2

Thermometers . . .
hydrometers . . .

SCIENTIFIC INSTRUMENTS

Made to I P., B.S S., S T C P T & A S T M specifications N P.L Certificates if required.



Set of Short Range, Short Stem thermometers made to B.S 1365 1951 In morocco leather case

Phone Liberty 2283-6

EST. ZECOL 1888

Telegrams Zealdom, Souphone, London

G. H. ZEAL LTD.

LOMBARD RD, MERTON, LONDON, S W.19

A NEW JOURNAL

VIROLOGY

EDITORS:

GEORGE K. HIRST, *Editor-in-Chief*
The Public Health Research Institute of the City of New York, Inc
New York 9, New York

L. M. BLACK
University of Illinois, Urbana, Illinois

S. E. LURIA
University of Illinois, Urbana, Illinois

ASSOCIATE EDITORS

C H ANDREWES
C A BRANDLY
SEYMOUR S COHEN
A H DOERMANN
JOHN F ENDERS
CHARLES A EVANS
WERNER HENLE
A D HERSHEY
FRANCIS O HOLMES
FRANK L HORSFALL, JR
HILARY KOPROWSKI
ANDRÉ LWOFF
JAMES W MOULDER
GLENN S POUND
THEODORE T. PUCK
A F ROSS
H K SCHACHMAN
EDWARD A STEINHAUS
ROBLEY C WILLIAMS
C E YARWOOD

RECENT DEVELOPMENTS in virology have emphasized the value of the comparative approach. Advances in one area of virus research often have important implications in others. The literature on virus subjects is widely scattered, mostly in journals which reach workers in only one area, and the desirability of a periodical exclusively devoted to virus science has been suggested by many investigators

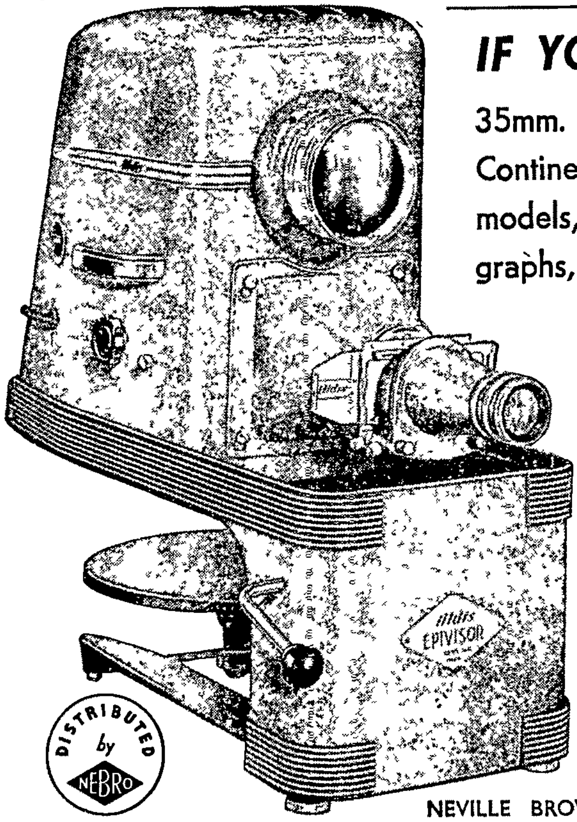
The purpose of *Virology* will be to publish articles on the biological, biochemical, and biophysical aspects of the subject, stressing contributions of a fundamental rather than applied nature. It is hoped that the journal will contribute to the integration of virus science by providing a ready introduction to all its fields.

It is planned to publish one volume per year. Volume 1, 1955, will consist of five issues, and will be priced at $9.00 Volume 1, Number 1, is scheduled for release during May 1955.

Manuscripts should be submitted to the Editorial Office, VIROLOGY, 125 East 23 Street, New York 10, N Y., U.S A.

Subscription orders should be sent to

Academic Press Inc., Publishers
125 East 23 Street, New York 10, N.Y., U.S.A.
British Office : ACADEMIC BOOKS LTD.,
129 Queensway, London, W.2



IF YOU WANT TO PROJECT

35mm. film strips, 2"x2" or $3\frac{1}{4}$"x$3\frac{1}{4}$" slides, Continental slides, micro slides, specimens, models, drawings, blueprints, photographs, graphs, etc., etc. . . .

THERE IS ONLY ONE ANSWER

Aldis 'EPIVISOR'

(Registered Trade Mark)

EPIDIASCOPE

This versatile instrument enables you to project greatly enlarged and perfectly defined images of flat and solid objects, as well as film strips and slides. It is indispensable in research and in training. Full details will gladly be sent on request, together with the name of your nearest dealer, who will be pleased to demonstrate.

Sole Wholesale Distributors:
NEVILLE BROWN & CO LTD, 77 NEWMAN ST., LONDON, W.1

METROVICK

SCIENTIFIC EQUIPMENT

includes the following products:—

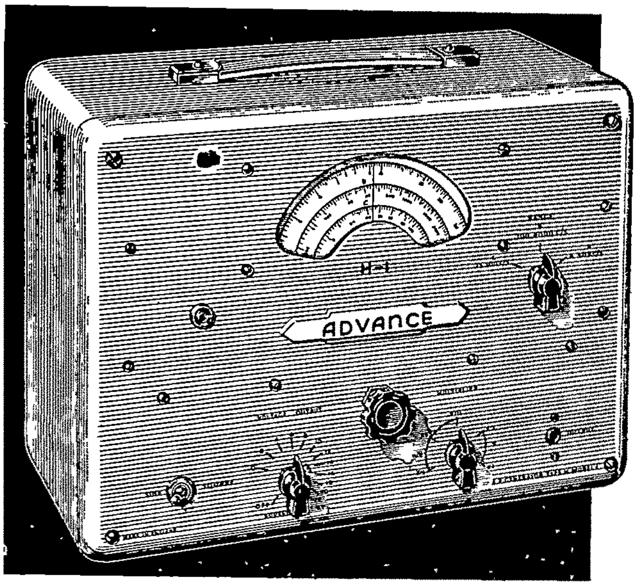
MASS SPECTROMETERS
ELECTRON MICROSCOPES
ELECTRON DIFFRACTION CAMERAS
H.V. IMPULSE GENERATORS
ROTARY VACUUM PUMPS
DIFFUSION PUMPS
VACUUM GAUGES & RELAYS
IONISATION & PIRANI TYPES
VALVES & OTHER VACUUM COMPONENTS

LINEAR ACCELERATORS
SYNCHROTRONS, BETATRONS and CYCLOTRONS
LABORATORY ELECTROMAGNETS
H.V. LABORATORY EQUIPMENT
COMPLETE VACUUM PLANTS
HIGH-SPEED RECURRENT WAVE FORM MONITOR
S. BAND TEST BENCH
S. and X. BAND SPECTROMETER

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER 17

N/R 402

Member of the A.E.I. group of companies



THE

Advance

TYPE H1

- Range 15 c/s. to 50,000 c/s.
- Stable output over full range
- Sine OR square wave output
- Distortion less than 1% at 1,000 c/s
- Accuracy ±1%, ±1 c/s
- Weight 14 lb
- Dimensions 13¼ in × 10¼ in. × 8 in.

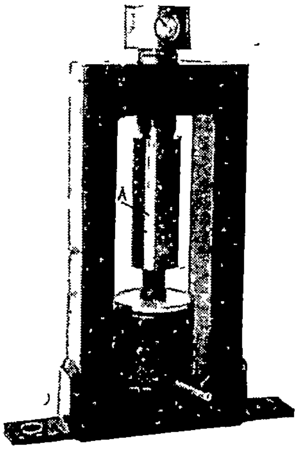
£25 (*List Price in U K.*)

Full details in Folder N/16 gladly sent on request

We are exhibiting on
STAND 30
R E C M F EXHIBITION
April 19th–21st
and on
STAND 21
THE PHYSICAL SOCIETY EXHIBITION
April 25th–28th

Advance audio generator

ADVANCE COMPONENTS LIMITED, MARLOWE RD., WALTHAMSTOW, LONDON, E.17. Tel · LARkswood 4366/7/8



GOOD
BUT
INEXPENSIVE

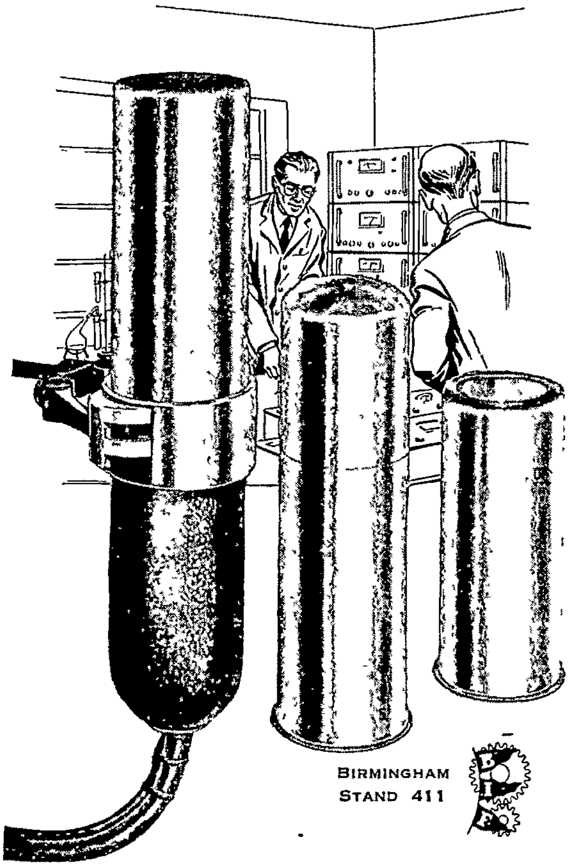
COMBINED DIE AND PRESS FOR THE PRODUCTION OF KBr AND OTHER DISCS FOR USE IN I.R. SPECTROSCOPY. DIAMETER OF DISC ½ IN.

Die based on the design evolved at King's College, London

Press of our own design (Brit. Pat App 17114/54). Moderate screw pressure only is required, and heating the central member A with a Bunsen burner for 30 seconds provides the additional pressure required to make a perfect transparent disc A temperature-sensitive paint shows when sufficient heat has been applied

PRICE COMPLETE IN U.K. £30

SIR HOWARD GRUBB, PARSONS & COMPANY
WALKER GATE, NEWCASTLE UPON TYNE 6
PROPRIETORS: C. A. PARSONS & COMPANY LIMITED



SCINTILLATION COUNTER HEAD

TYPE 653

A universal unit for fundamental research into nucleonics—medical, clinical and diagnostic routine investigation

Special end caps and lead collimator are provided with thi equipment for Alpha, Beta and Gamma rays, X-Ray Spectrometry and neutrons using crystalline and plastic phosphors

Ancillary Isotope Apparatus available for complete scintillation techniques includes.

EXTREME STABILITY E H T UNIT, WIDE BAND AMPLIFIER, PULSE ANALYSER, SCALER

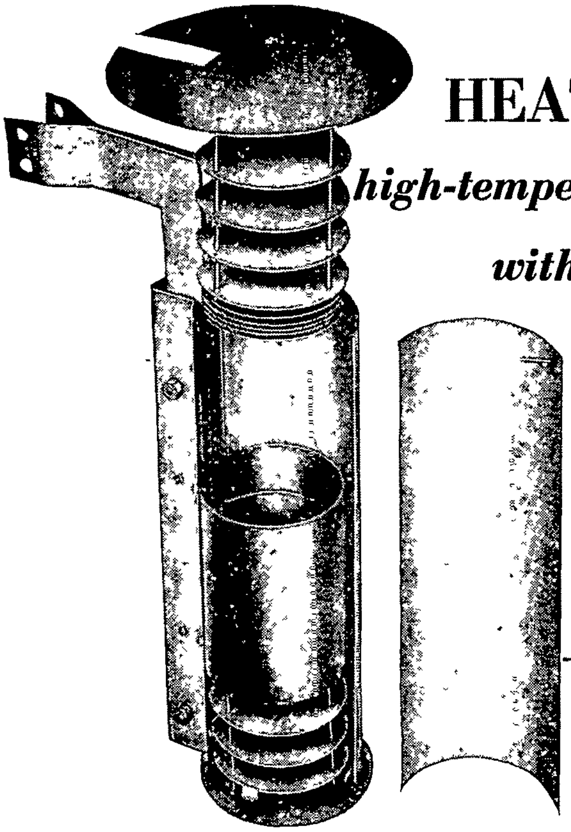
Detailed specifications from

ISOTOPE DEVELOPMENTS LTD.

120 · MOORGATE · LONDON · E.C.2
Telephone METropolitan 9641 (5 lines)

Midland Agent HAWNT & CO LTD, 59 Moor St, Birmingham,
(Telephone Central 6871)
Northern Agent A M LOCK & CO. LTD, Crompton St, Chadderton
Oldham, Lancs (Telephone Main 6744)
Scottish Agent A R BOLTON & CO, 72 Haymarket Terrace,
Edinburgh, 12 (Telephone Edinburgh 62446)

BIRMINGHAM
STAND 411



HEATING ELEMENT *for a high-temperature VACUUM FURNACE with RADIATION SHIELDS*

FABRICATED COMPLETELY FROM

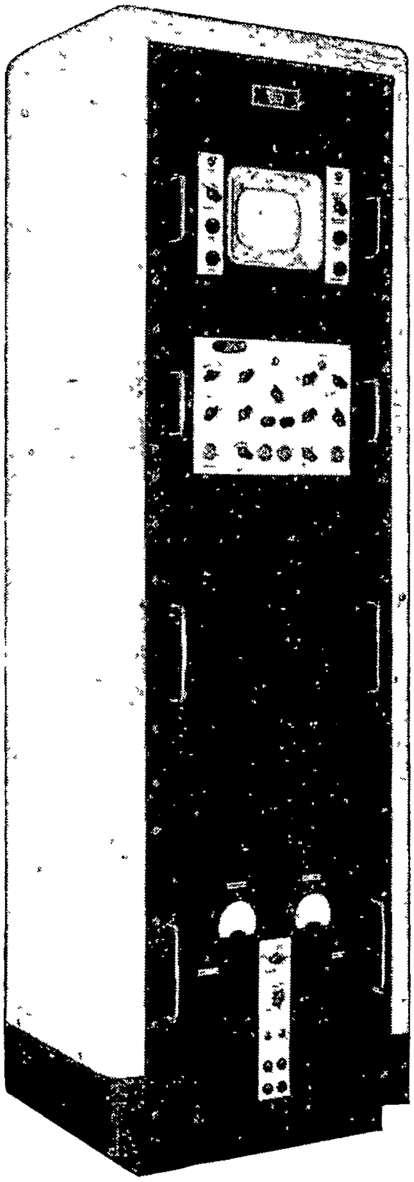
TUNGSTEN and MOLYBDENUM SHEET

BY MUREX LIMITED

MUREX LIMITED *(Powder Metallurgy Division)*
RAINHAM · ESSEX · *Telephone: Rainham, Essex* 3322
London Sales Office: CENTRAL HOUSE, UPPER WOBURN PLACE, W.C.1. *Telephone: EUSton* 8265

PROGRESS IN CONTROL

SUNVIC
PULSE HEIGHT
ANALYSER



An instrument for the analysis of a complex pulse amplitude spectrum into groups of known height according to their voltage amplitude.

It displays up to a maximum of 120 channels and can store 1,200 binary digits. The design is based on that of Hutchinson & Scarrott (*Phil. Mag.*, 42, 792, 1951) and the instrument is made under licence from the N.R.D.C.

EQUIPMENT BY SUNVIC

SUNVIC CONTROLS LTD (Special Products Division), No. 1 Factory, Eastern Industrial Estate, Harlow, Essex. Telephone Harlow 24231/5
Manufacturers of Pneumatic and Electrical Instruments for detection, measurement, control and recording of Temperature, Flow, Liquid Level, Specific Gravity and Pressure, in Science and Industry Vacuum Pumping and Measuring Equipment, etc
Member of the A.E.I. Group of Companies

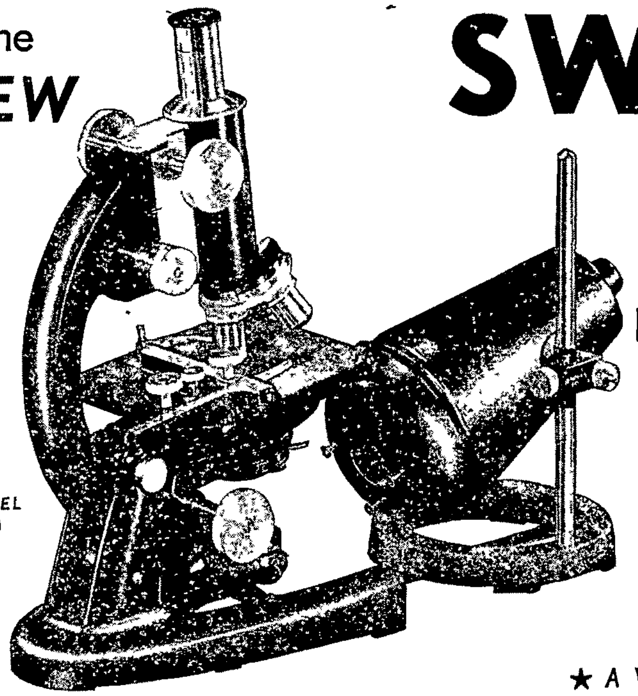
TAS/Sc.305

The NEW

SWIFT

★ 'CENTURY'

MICROSCOPES



STUDENTS' MODEL
(with attachable
mechanical stage
and lamp)

- Brochures and prices on request
- Demonstrations arranged

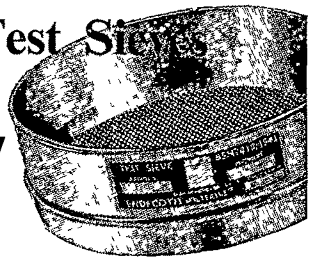
★ A WIDE RANGE OF PURPOSEFUL AND ADAPTABLE INSTRUMENTS BASED ON THE EXPERIENCE OF 100 YEARS OF FINE INSTRUMENT MAKING

JAMES SWIFT & SON LTD., 113-115A CAMBERWELL ROAD, LONDON, S E 5 RODney 5441

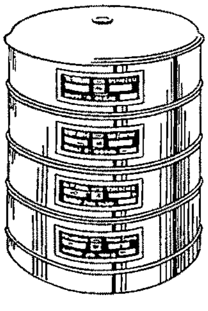
ENDECOTT'S

Standard Test Sieves

for Accuracy!



To B S.S or American Standards



Accurate sampling or testing is essential and Endecott's Test Sieves are *guaranteed* to conform to specification The patent sieve body contains no crevices or blind spots to impair test efficiency Durability is assured by attachment of the wirecloth direct to sieve frame, giving uniform tautness and long life Standard sizes are available *from stock*, special requirements can be satisfied promptly

Test Sieve Vibrators
Pocket Interchanger Sieves
Write for literature

ENDECOTT'S (FILTERS) LTD

251, Kingston Road, London, S W 19 Liberty 8121/2

FOR pH CONTROL

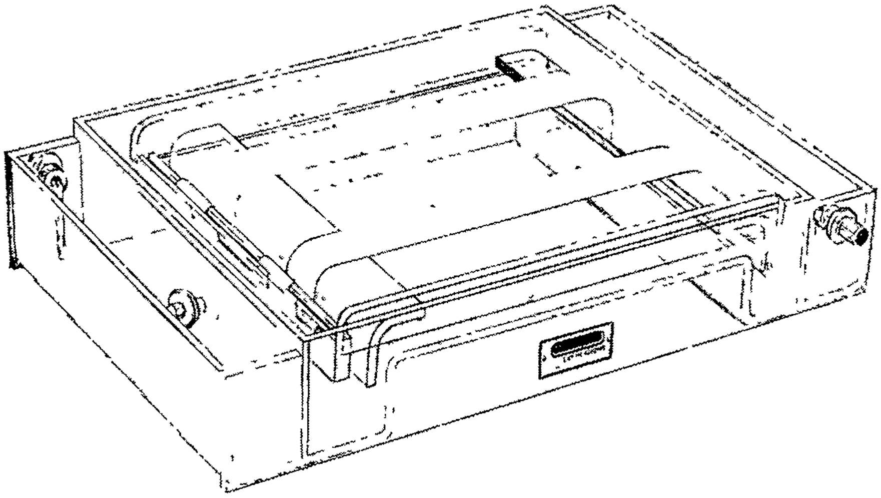
JOHNSONS OF HENDON offer to chemists and manufacturers this useful series of five test papers for the measurement of pH values. UNIVERSAL is one paper covering completely the range from pH 1 to pH 10, enabling pH values to be checked to within 0.5 pH. COMPARATOR test papers make a set of four separate indicators for obtaining still greater accuracy by determining the pH value of any solution to within 0 3 pH.

Descriptive leaflet will be sent free on request.

JOHNSONS OF HENDON LTD.
LONDON, N W 4 ESTABLISHED 1743

EL CTROPHOR IC TAN

WITH AUTOMATIC PAPER TENSIONER AND PLATINUM-COATED ELECTRODES



This new electrophoresis tank, made entirely from transparent material, has a greatly increased working width of 8 in, so that 3 or 4 strips can be run comfortably at a time

The strips are securely located on a removable bridge and kept under constant tension by a simple device which automatically prevents sagging

The centre of the tank is raised, thus reducing the air space and minimising evaporation Beneath the bottom of the migration chamber crushed ice or other coolants can be conveniently placed for working at lower temperatures

SHANDON

Also available Vertical Paper Electrophoresis Tanks DC Power Packs with 110, 250 or 1000 V output Latest Continuous Electrophoresis Apparatus with the new 'liquid electrode' assembly according to Holdsworth . Densitometers Antweiler Micro Electrophoresis Apparatus

SHANDON SCIENTIFIC CO. LTD., 6 Cromwell Place, London, S.W 7 KNIghtsbridge 1131

Manufacturers of optical elements for laboratories and instrument makers

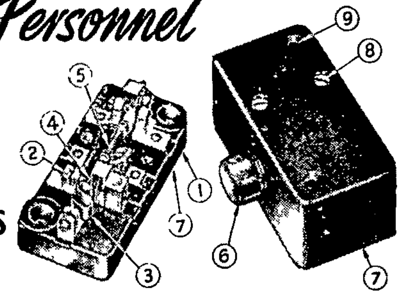
✻

M. Bender (Northern) Ltd.

Optical Works—
5-21, High Friar Street,
Newcastle upon Tyne, 1
Tel 2-4005/6

Safeguard Apparatus, Plant & Personnel with

THERMAL DELAY SWITCHES by "BELLING-LEE"



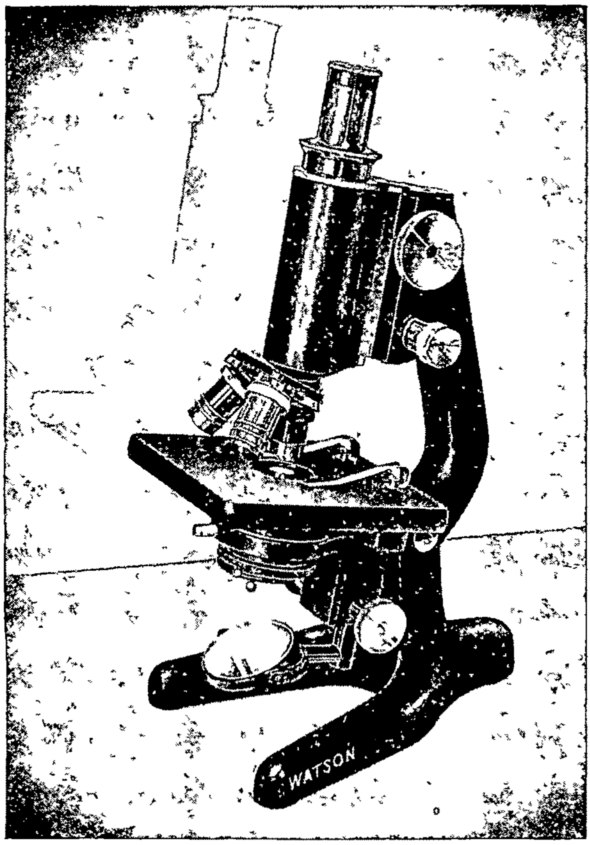
Hand Reset Version L 415
Automatic Reset Type L 413

DESIGN FEATURES

1 Moulded base of robust design with thermal and dimensional stability
2 Short, rigid contact and support pillars
3 Quick "make" and "break" with follow-through action achieved by use of hardened beryllium copper toggle spring—consistent throughout the life of the delay switch Contact speed of "make" and "break" approximates to condition of minimum arc energy, thus assisting effective interruption of circuit and prolonging the life of the contacts
5 Operation direct by resistive bi-metal or separate heating elements
6 "Trip-free' push button, spring loaded, in hand reset version L 415
7 Back or front panel connections provided for Knock-out sections at sides of base and cover Connection tags identified numerically for ease of wiring

Please write for P 347

BELLING & LEE LTD
GREAT CAMBRIDGE RD., ENFIELD, MIDDX., ENGLAND



MICROSCOPES

THE "SERVICE II" MICROSCOPE

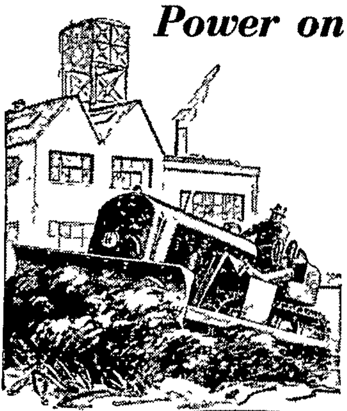
meets the exacting requirements of the student or technician. Its excellent construction and performance are worthy of the Watson tradition

Write for List 3A.

WATSON'S

W. WATSON & SONS LTD · 313, HIGH HOLBORN, LONDON, W.C.1.

Keeping Mechanical Power on the move!

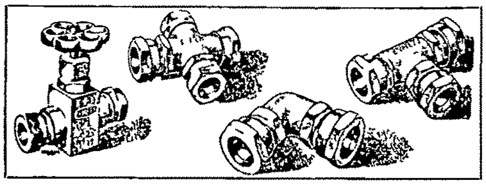


In the building of powerful diesel engines Ermeto Valves and Couplings are a standard specification just as they are in scores of other industries Renowned throughout the world for their vibration-proof and pressure holding qualities they are specified by designers and production engineers everywhere The secret is in the Ermeto ring which cuts its own sealing flange as you tighten the locking nut

Ermeto joints have no equal

ERMETO VALVES & COUPLINGS

Regd Trade Mark



BRITISH ERMETO CORPORATION LTD,
Maidenhead, Berks, England Telephone Maidenhead 2271/4

THE PHYSICAL SOCIETY'S
39th EXHIBITION
of
SCIENTIFIC INSTRUMENTS AND APPARATUS
will be held at the
ROYAL HORTICULTURAL SOCIETY'S NEW HALL
Greycoat and Elverton Streets, Westminster, S.W.1
from 25th–28th April, 1955

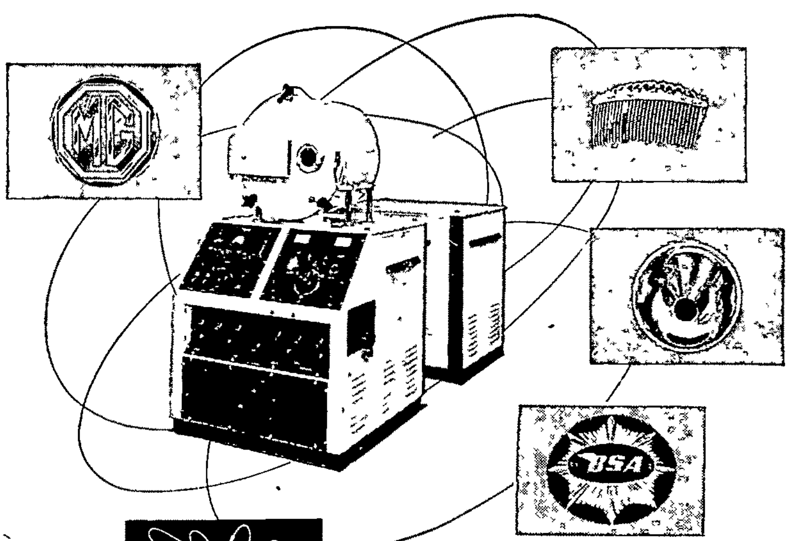
The *Handbook*, which will be published in connection with the Exhibition, is not only a catalogue, but is a most valuable reference book of new developments in British scientific instruments and apparatus

During the Exhibition, discourses on scientific subjects of general interest will be given.

The Annual Craftsmanship and Draughtsmanship Competition takes place early in the year, and the winning entries will be exhibited.

1, Lowther Gardens, Prince Consort Road,
London, S.W.7

Thin Films... COATINGS WITH V.I.A. HIGH VACUUM PLANT



Fast processing cycles economically use expensive metals.

The Coating Unit illustrated is one of the V I A range which has been developed for high vacuum processing Single or multiple layers can be applied and may be used for large scale production on mirrors plastic jewellery, lenses, reflectors and the deposition of decorative metallic films on specialised products

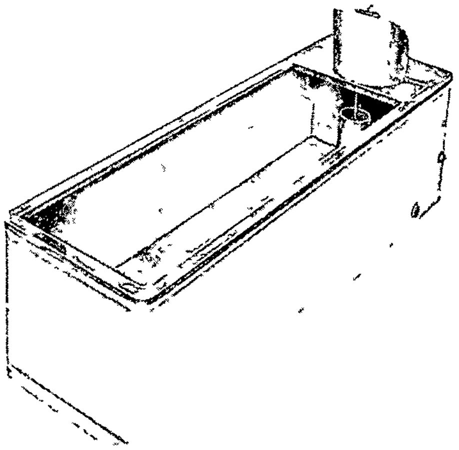
High quality appearance by the economic use of expensive metals obtained with considerable saving on production costs

VIA-VAC

Specialist manufacturers of industrial vacuum equipment — consulting service to industry.

VACUUM INDUSTRIAL APPLICATIONS LTD., WISHAW LANARKSHIRE

"CUSTOM BUILT" THERMOSTATIC BATH



The Standard L T E Baths are designed to have the widest range of applications and are available in four sizes Temperature ranges from room temperature or slightly below, using the cooling unit, to 100° C Deviation from the desired mean temperature is within 0 5° C Sensitive temperature control ensures adequate performance under all conditions Racks and fittings are available for all the standard tests and "Custom Built" racks and fittings are made to specifications

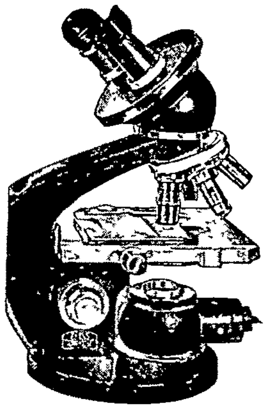
Please send for illustrated catalogue to—

LABORATORY THERMAL EQUIPMENT L^{TD}

GREENFIELD, Nr Oldham, England Tel Saddleworth 552

CARL ZEISS

W MODEL MICROSCOPE



The pre-eminent instrument Integral illumination Pre-centred condensers Immediate change from bright field to phase contrast Optovar magnification changer

DEGENHARDT & CO., LTD.

32 MADDOX STREET, LONDON, W 1
Mayfair 6639
Sole Importers for Gt Britain and N Ireland

Isomantle

REGD TRADE MARK

MULTISIZE OUTFIT

The Handy Storage Box contains a complete electrical heating set for the laboratory.-

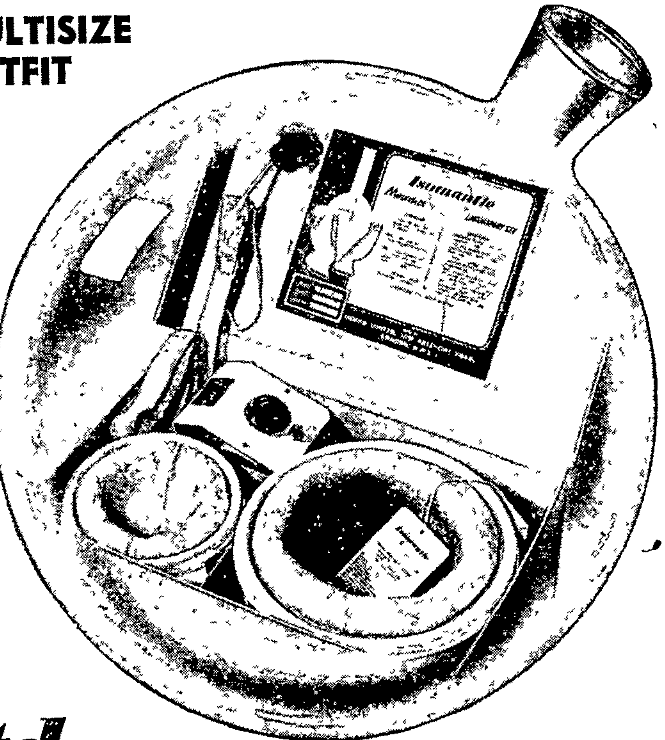
2 Multisize Isomantles to heat all flasks from 50 ml. to 2 litre capacity,

1 Isotape fully insulated electric heating tape, and

1 Energy Regulator

SET/500-2 ... ... £19 5s. 0d.

This is one of the many Laboratory Heaters described in Catalogue LM, which we shall gladly send on request Our Design Department is at your service for any special heating requirements. Isomantles are built to last, they are simple to run, efficient and of neat appearance The MULTISIZE design is covered by British Patent No. 711365 Twelve months guarantee.

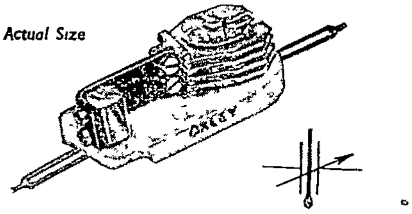


Isopad Ltd.,

30-32 Rosemont Road, London, N.W.3 Telephone HAMpstead 8466/7

Excellence in design...

Specialists in Sub-miniature Telecommunication Components



TEMPATRIMMER

Nominal capacity 6 5pF — Temperature Coefficient continuously adjustable from + 2000 to — 2000 parts per million per degree Centigrade Length 1 31″, Width 670″; Height .5″

OXLEY

DEVELOPMENTS CO. LTD.

ULVERSTON NORTH LANCS Tel: Ulverston 3306

SINGER

Micromanipulators

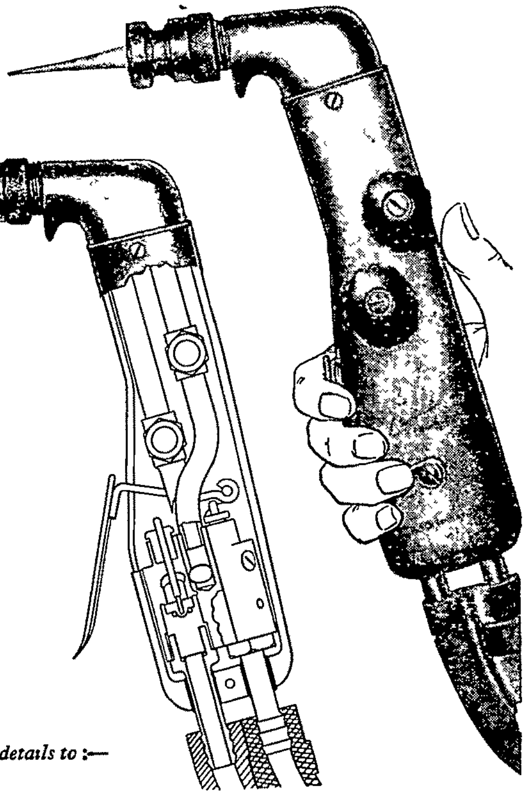
Singer (High-power) Micromanipulators are suitable for use under magnifications of from × 100 to × 1,000 diameters *plus*, as described by Barer and Saunders-Singer in the *Quarterly Journal of Microscopical Science*, Vol. 89, pp. 439-447, December, 1948.

Singer Microdissectors (Low-power Micromanipulators) are suitable for use under magnifications of from 1 to ×200 diameters and are described by Barer and Saunders-Singer in the *Journal of Scientific Instruments*, Vol. 28, pp. 65-68, March 1951.

●

SINGER INSTRUMENT COMPANY LTD.

83, London Street, Reading



Where will it turn up next?

The Flamemaster torch turns up in the most unlikely places and among a surprising number of trades Our books show that glass blowers, laboratory technicians, jewellers, dental mechanics and all kinds of metal workers were among the first to welcome this new precision heating tool, and that recently we've had orders from model engineers, electrical engineers, lead-burners and garage mechanics

Why do they all find the Flamemaster so handy ?

Because Installation is extremely simple
Flame control is easy and reliable
Waste is eliminated by our trigger grip economiser
Leaks are impossible.

FLAMEMASTER MARK II

If you'd like to deal with your heating problem in the up-to-date way, write for full details to :—

STONE-CHANCE LIMITED, DEPT F12, LIGHTHOUSE WORKS, SMETHWICK 40, BIRMINGHAM TELEPHONE BROADWELL 2651
LONDON OFFICE 28 ST JAMES'S SQUARE, S W 1. TEL WHITEHALL 6002

ATTACHABLE
MECHANICAL STAGES
To fit any round or square-stage microscope
Prices from £7.10s to £10 10s
IMMEDIATE DELIVERY—Illustrated leaflets on request
ALBERT GOLDER & CO, 137 DAIRSIE ROAD, ELTHAM
LONDON, S E 9 Phone ELTham 5126
Trade Supplied

HIGH VACUUM STOPCOCKS

Individually Tested and Guaranteed
(A E R E Harwell approved)
New Catalogue on request to
G. SPRINGHAM & Co. Harlow New Town
"The Stopcock People" HARLOW 24108

OPTICAL FLATS & PROOF PLATES

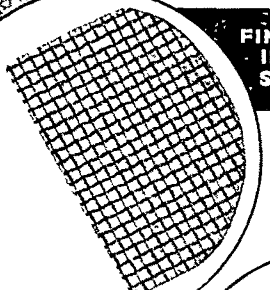
Your requirements may be listed in our Lens and Prism Leaflet but, if not, we would be glad to quote for making to specification.

Our illustrated leaflets are available on request. Listed are many Second-Hand and Ex-Government items of Photographic, Optical and Scientific interest

CHARLES FRANK
Instrument Makers and Dealers since 1907
67/73, SALTMARKET, GLASGOW, C.1
Phone Bell 2106 and 2107

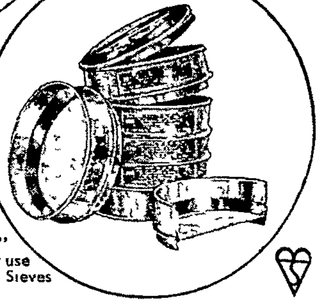
Greenings
N GREENING & SONS LTD
BRITANNIA WORKS
WARRINGTON · ENGLAND
P.O Box 22

FINE WIRE GAUZE IN MONEL AND STAINLESS STEEL



Controlled supervision at all stages of manufacture ensures that our Wire Gauze has the highest degree of accuracy obtainable

TEST SIEVES TO B.S.S. 410/1943



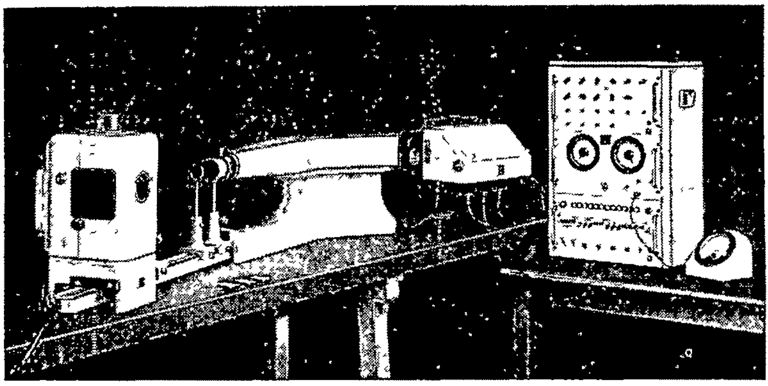
Conforming to all the requirements of the above Standard Specification, including "Specials" and "Wet" Sieves for Laboratory use
Commercial quality Sieves also supplied

COMPREHENSIVE STOCKS ALWAYS AVAILABLE AT WARRINGTON & HAYES

N.G13

DIRECT READING

Spectrochemical Analysis



UP TO TEN ELEMENTS can be quickly and accurately analysed with the Direct Reading Attachment to the Hilger Medium Quartz Spectrograph

The plateholder of the spectrograph is replaced by a unit which will accommodate eleven photomultipliers and slits adjusted accurately on appropriate spectral lines A complete analysis takes under three minutes

Extensive tests have shown that sensitivity is high and reproducibility often better than is obtained with photographic methods

A new design of arc and spark stand ensures that samples are aligned rapidly and precisely Either pencil electrodes or flat specimens can be examined with equal ease.

Provision is made for compensating for variations of temperature

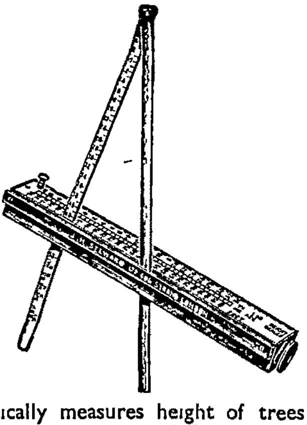
The attachment has been used in determining the composition of aluminium, lead, magnesium and other alloys Results of tests carried out in the Hilger laboratories will be forwarded on request

Please write for Hilger catalogue CH 383 (*N*.3) *for description of the instrument and CH* 392 (*N* 3) *for applications and results*

HILGER & WATTS LTD.
98 St. Pancras Way, Camden Road
London, N.W.1, England

Member of the Scientific Instrument Manufacturers' Association and of SCIEX

AUTO-SIMPLEX TREE and HEIGHT MEASURER



Automatically measures height of trees, etc , at any measured distance
In leather case with instructions

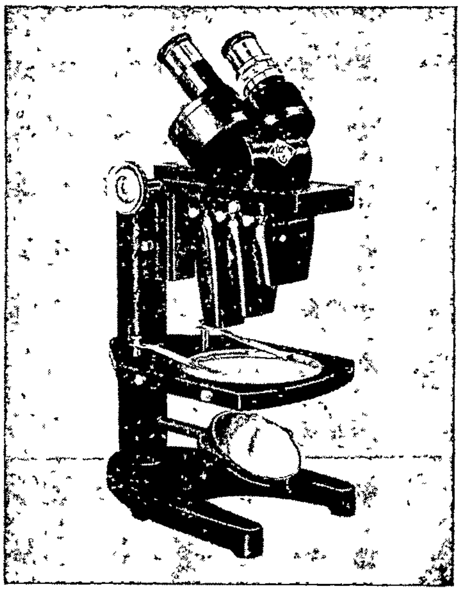
Price £10 15 0

Details of Tree Borers, Soil Samplers and Pocket Surveying Instruments on request.

J. H. STEWARD, LTD.
Opticians and Scientific Instrument Makers
406 STRAND, LONDON, W.C.2

The Hall-mark of a PRIOR *Precision-built Microscope*

STEREOSCOPIC MICROSCOPES



W. R. PRIOR & CO. LTD.
NORTHGATE END, BISHOP'S STORTFORD
HERTFORDSHIRE

Republic of China), and science and its social relations (Prof. A R. Wadia). Among the special lectures, the following may be mentioned synthesis and stereochemistry of carotenoids (Prof Paul Karrer), metallogenetic provinces and epochs in Japan (Prof T. Watanabe), extensive showers of cosmic rays (Prof P Auger), iron and manganese resources of Japan (Prof T Watanabe), present state of geological education in Japan (Prof T Watanabe), structure of proteins (Prof Linus Pauling), soda ash industry (Dr T P. Hou), and Chinese herbal medicines (Dr Hsieh Yu)

The meetings of the Executive Committee and of the Council of the Indian Science Congress Association were held on January 3 The meeting of the General Committee was held on January 8, at which it was announced that Dr B C Roy was elected as general president for the session 1957, that is, for the year 1956–57 As announced last year, Dr M S Krishnan, director of the Geological Survey of India, will be general president for the year 1955–56 The next session of the Indian Science Congress will be held in Agra in 1956.

THE MASS SPECTROSCOPE

THE handbook, prepared by M G Inghram of the University of Chicago, and R J Hayden of the Argonne National Laboratory, for the Subcommittee on Instruments and Techniques of the Committee on Nuclear Science of the National Research Council*, presents in some detail the fundamental design and operational techniques pertinent to the efficient utilization of the mass spectroscope Attention is directed mainly to the ionic type of mass analyser with either electrical or photographic ionic detection No attempt is made to discuss the wide range of application of mass spectroscopes or to include particulars of the associated electronic circuits, but adequate references to articles on these topics are given

The handbook consists of four sections In the first the equations appropriate to the various types of analysers are stated and explained They relate mainly to instruments with focusing properties A table, in which some seventy different instruments grouped according to type and field arrangement are listed, follows The theories to be applied to all instruments of a given type are similar, and the major differences are largely of constructional detail, some of which, together with the names of the constructors of the instruments and dates of publication, are specified in the table or discussed at length in the text. The second section is devoted to the important problem of suitable ion sources, and the various types are classified according to their primary uses and their sensitivities A table is included showing the compounds appropriate for analysis of each of the elements up to bismuth from gaseous, crucible or surface ionization sources, together with an indication of the preferred source In the third section brief consideration is given to the problems of sample introduction into the ionization region of the mass spectrometer where, unless special precautions are taken, the relative intensity of the ion beams formed by the source will not be characteristic of the sample.

The final section deals with ion detectors, and in addition to the conventional photographic plate and electrometer the use of photomultipliers and scintillation counters is discussed and the design and construction of several types of detectors are outlined and shown schematically

The handbook concludes with a bibliography of more than two hundred references, and though these refer to dates earlier than April 1952 when the manuscript was completed, the report as a whole represents a most valuable source of information on basic principles and procedures of mass spectroscopy

S WEINTROUB

* National Academy of Sciences National Research Council Nuclear Science Series—Report No 4 Mass Spectroscopy By Mark G Inghram and Richard J Hayden (Prepared for the Subcommittee on Instruments and Techniques of the Committee on Nuclear Science, Division of Physical Sciences, National Research Council) Pp iv+51 (Washington, D C National Academy of Sciences, 1954)

THE GLOBAL RADIATION IN A RAYLEIGH ATMOSPHERE

By DIRAN DEIRMENDJIAN and ZDENEK SEKERA

University of California, Los Angeles, California

THE publication of Chandrasekhar's treatise, "Radiative Transfer"[1], marked an important step in the exact treatment of radiation problems in a scattering medium. One such problem, the complete quantitative description of the radiation field in a scattering atmosphere according to the laws of Rayleigh, was solved as an illustration of the possibilities of the new method. Its success has already been demonstrated by Chandrasekhar and Elbert[2] in explaining the main characteristics of the sky-light polarization observed on clear days

Another application of the method consists of finding the total flux of energy, as a function of the wave-length and direction of the unpolarized light, received at the lower boundary of a plane-parallel scattering atmosphere of finite depth illuminated by parallel radiation of a given flux from a single direction Under certain assumptions, in the case of the terrestrial atmosphere this constitutes what is known as the 'global radiation' It can be shown[3] that the relative global radiation, that is, that arising from an incident flux of unit strength at the corresponding wave-length, can be derived from Chandrasekhar's discussion, in which the independent variables are the optical thickness (defining the wave-length) and the parameter $\mu_0 = \cos \Theta_0$, where Θ_0 is the zenith distance of the sun The resulting expression is a very simple one in terms of the functions γ_l and γ_r, which are identical with those mentioned in equations (7) and (8) of ref 2. We have then

$$G(\tau,\mu_0) = \tfrac{1}{2}\mu_0[\gamma_l(\tau,\mu_0) + \gamma_r(\tau,\mu_0)], \qquad (1)$$

in which $G(\tau,\mu_0)$ represents the relative global radiation, that is, the flux of the sun and sky radiation through a horizontal surface, resulting from the multiple scattering of the incident light The functions $\gamma_l(\tau,\mu_0)$ and $\gamma_r(\tau,\mu_0)$ give the individual contributions of the components of the incident light polarized in directions parallel and normal to the vertical plane through the sun respectively, and their sum,

$$\frac{G(\tau,\mu_0)}{\mu_0} = \tfrac{1}{2}[\gamma_l(\tau,\mu_0) + \gamma_r(\tau,\mu_0)], \qquad (2)$$

is evidently the relative flux through an area normal to the incident parallel unpolarized light The variation of this function with the wave-length and angle of incidence Θ_0 can be appreciated from the curves of Fig 1. These curves are based on values obtained from the fundamental functions X_l, Y_l, X_r and Y_r as defined by Chandrasekhar, which were computed by the IBM system and tabulated in the form of two scientific reports[4,5] (now also available in more detail as computed by S. Chandrasekhar and D D Elbert in *Trans Amer. Phil Soc*, New Series, **44**, Part 6 (1954))

The relative sky radiation is easily found by subtracting from (1) the reduced flux of the direct solar radiation, so that

$$H(\tau,\mu_0) = \tfrac{1}{2}\mu_0[\gamma_l(\tau,\mu_0) + \gamma_r(\tau,\mu_0)] - \mu_0 \exp(-\tau/\mu_0), \quad (3)$$

in which $H(\tau,\mu_0)$ is the sky radiation arising from a unit incident flux and the last term on the right is the reduced flux of parallel radiation coming from the direction $\Theta_0 = \cos^{-1}\mu_0$ Returning to the curves of Fig 1, they appear to be quite regular and their character changes little except for very large values of Θ_0 The curve marked 88 8° is equivalent to local sunset conditions in the sense that the corresponding attenuation in the plane-parallel atmosphere equals that along the finite path in the real atmosphere. The peculiar shape of this particular curve is explained by the fact that at such an oblique incidence the pure sky radiation dominates the direct sunshine in the blue and green part of the spectrum. This is exhibited by the broken-line curve representing the sky radiation H/μ_0 obtained from (3), so that the full curves may also be thought of as representing the sum

$$\frac{G(\tau,\mu_0)}{\mu_0} = \frac{H(\tau,\mu_0)}{\mu_0} + \exp(-\tau/\mu_0). \quad (4)$$

In a discussion of the global radiation, the effect of the earth's planetary reflexion cannot be disregarded. When this is assumed to follow the simplest possible law, namely, Lambert's law, it can be shown[3] that it is sufficient to multiply the expression in (1) by a correction factor

$$\frac{1}{1 - \Lambda\bar{s}(\tau)}, \quad (5)$$

where $\bar{s}(\tau) = 1 - \int_0^1 [\gamma_l(\tau,\mu) + \gamma_r(\tau,\mu)]\mu d\mu$, and Λ represents the albedo of Lambert reflexion. This factor is such that, if, for example, $\Lambda = 0$ 25, it amounts to 1 126 at $\tau = 1$ 00 ($\lambda = 3120$ A. at sea-level) and it approaches unity asymptotically as the optical thickness tends to zero.

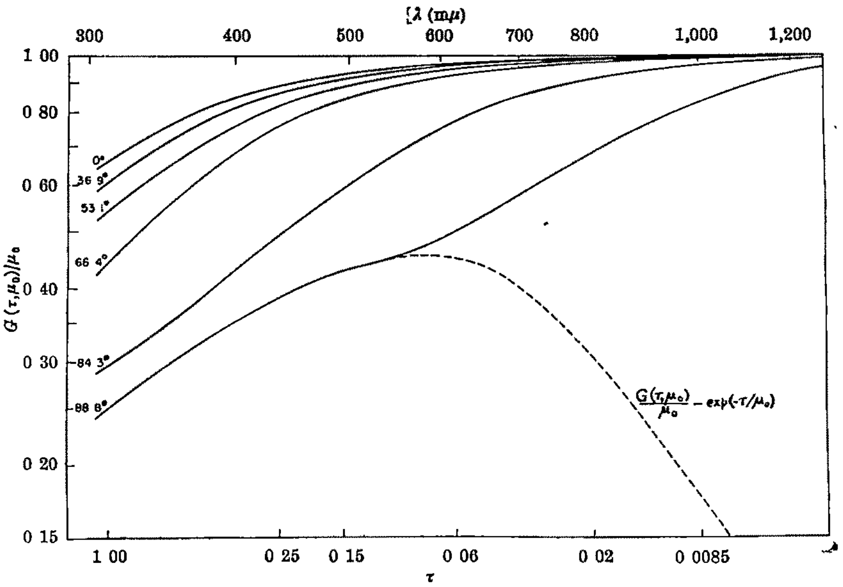


Fig 1 Plots of the global radiation function defined in equation (2) of the text Calculations were made at the values of the optical thickness shown on the bottom scale

If the spectral energy curve representing the fluxes of solar radiation before penetration into the atmosphere is given, it is easy to determine the global radiation at the earth's surface, once the function (1) is known. Its values have been computed in detail and will appear elsewhere[3]. An example of the absolute global radiation obtained in this way is shown in the diagram of Fig 2, in which the solar energy distribution given by Nicolet[6] was used (uppermost curve marked $\pi F_{0\lambda}$) The top of the thick curve in each case gives the global radiation including Lambert reflexion with an albedo of 0 25. The situation for three different solar zenith distances is shown, corresponding to 0°, 53 1° and 84 3°, respectively. It is interesting to note that the global radiation with the sun at 53 1° from the zenith should not be much different in spectral distribution from the global radiation for an overhead sun, though the amount of radiation is considerably less in the former case The inked-in areas in Fig. 2 represent the contribution from terrestrial reflexion with an

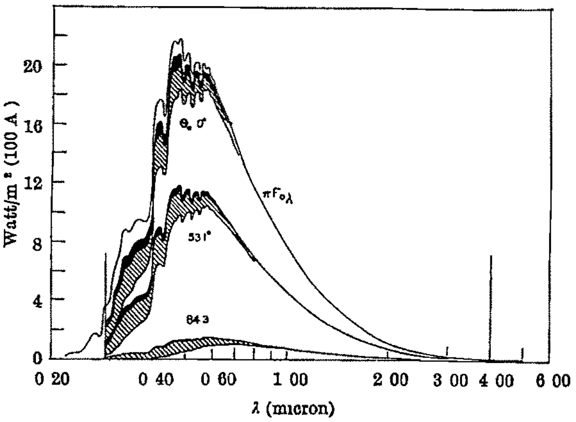


Fig 2 Global radiation according to the extended Rayleigh theory at various solar zenith distances (Θ_0), in the case when the solar energy before entering the atmosphere is given by the top curve marked $\pi F_{0\lambda}$

albedo of 0 25, and the hatched areas the pure sky radiation component

This pure sky radiation is shown separately in Fig. 3, in which the vertical scale has been expanded for greater clarity. The curves here represent the energy originating from the whole sky and received by a horizontal area at sea-level in watts per square metre and per 100 A interval centred at the wave-length of the corresponding ordinate. The exact character of the blue Rayleigh sky-light can be appreciated for the first time, in a way that includes the effects of all orders of scattering An interesting feature is that the maximum of this sky-light shifts towards the green when the sun is close to the horizon. The broken-line curve in Fig. 3 stands for the sky radiation when the earth is reflecting according to Lambert's law with an albedo of 0 25 and the sun occupies the local zenith, at which time the reflexion correction assumes its maximum value

Finally the integrated global radiation (for example, what would be measured by an instrument like the Eppley pyrheliometer) and the integrated sky radiation are given by the areas under the curves of Figs. 2 and 3, respectively. If the integration is done between wave-lengths 0 29 μ and 4 00 μ with an extra-terrestrial energy amounting to 1390 55 watts per square metre according to Nicolet's curve, the corresponding integrated global and sky radiation would be

	$\Theta_0 = 0°$	53 1°	84 3°
Global radiation			
No earth reflexion	1330 7	779 5	110 5 watts/m ^{2}
With reflexion albedo 0 25	1352 1	791 5	112 3 „
Sky radiation only			
No earth reflexion	57 0	50 9	23 8 „
With reflexion, albedo 0 25	78 4	62 9	25 6 „

The above values check fairly well with actual results obtained under clear sky conditions, however, a real check of the theory must await more detailed measurements giving the spectral distribution of the global and sky radiation. It is to be expected that this quantity will differ from the Rayleigh values according to the amount and properties of the atmospheric particles which scatter light according to a law different from Rayleigh's law. [Oct. 4

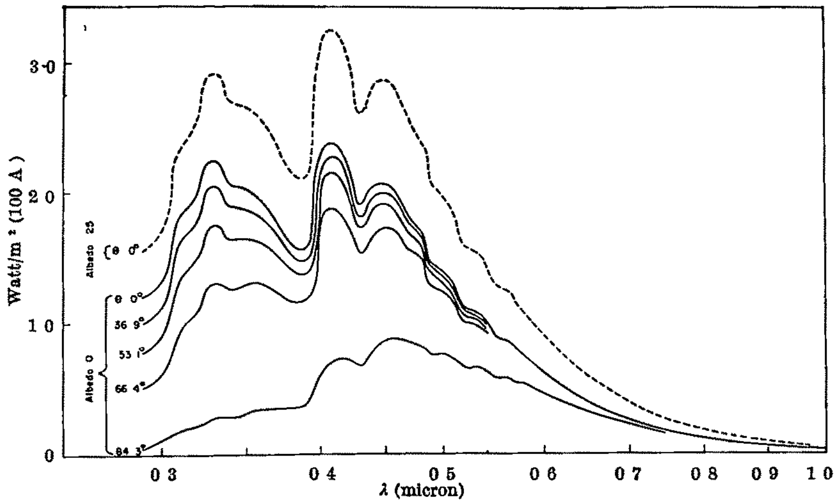


Fig 3 Pure sky radiation under the same assumptions as for Fig 2 Note the change in the vertical scale The broken-line curve represents the sky radiation under an overhead sun, after it has been corrected for Lambert reflexion with an albedo of 0 25

---

[1] Chandrasekhar, S, "Radiative Transfer" (Clarendon Press, Oxford, 1950)

[2] Chandrasekhar, S, and Elbert D, *Nature*, **167**, 51 (1951)

[3] Deirmendjian, D, and Sekera, Z, *Tellus* (in the press)

[4] Sekera, Z, and Blanch, G, "Tables Relating to Rayleigh Scattering of Light in the Atmosphere", Sci Rept 3, Contr *AF* 19 (122)-239, Air Force Cambridge Research Center, Cambridge, Mass (1952)

[5] Sekera, Z, and Ashburn, E V, "Tables Relating to Rayleigh Scattering of Light in the Atmosphere", *NAVORD* Report 2061, China Lake, Calif (1953)

[6] Nicolet, M, *Ann d'Astrophys*, 14, 249 (1951)

PITUITARY AND ADRENAL INFLUENCES ON THE COMPOSITION OF LIVER CYTOPLASM

By Dr. E REID

Chester Beatty Research Institute, Institute of Cancer Research, Royal Cancer Hospital, London, S W 3

HORMONAL influences on liver composition, as revealed by differential centrifugation[1], have so far received no attention comparable with that given to cancerous changes in liver Nucleic acid analyses performed on whole liver, particularly in the laboratories of Li[2] and of Di Stefano[3] (as reviewed elsewhere[4]), have shown that, after adrenalectomy or hypophysectomy, ribonucleic acid diminishes, either in absolute amount or at least relative to deoxyribonucleic acid, and that growth hormone can reverse this effect of hypophysectomy The intracellular site of these changes has now been investigated

The investigation was carried out with albino rats, arranged in groups such that experimental rats could be compared with control rats (intact or sham-operated) which had received the same amount of food and which were killed on the same day, a procedure adopted to minimize variability due to any day-to-day variations in technique or conditions The effect of hypophysectomy was studied in males of about 200 gm weight, some of which received growth hormone (0 3 mgm./day for eight to twelve days). The controls included not only pair-fed rats but also some rats fed *ad libitum* The effect of adrenalectomy was studied in females of about 250 gm weight, some of which received injections of cortisone acetate (2 mgm /day for six to eight days), saline was given in place of drinking water.

After a post-operative period of two to three weeks and following an overnight fast, the rats in each group were anaesthetized with 'Nembutal', and the liver perfused *in situ* with cold 0 25 *M* sucrose solution, as afterwards used for the differential centrifugation[1]. A minced sample of liver was homogenized in a Potter-type homogenizer, and the homogenate centrifuged to remove 'debris' containing the

Table 1. YIELDS (gm. per 100 gm. BODY-WEIGHT) OF LIVER FRACTIONS

Fraction	Control rats (mean value)	Experimental rats (values as per cent of values for control rats)*			
		Hypophysectomized	Hypophysectomized + growth hormone	Adrenalectomized	Adrenalectomized + cortisone
Whole liver (wet weight)	3.36	108.2 ± 2.7 (n = 20, P < 1%)	129.9 ± 8.4 (n = 11, P < 2.5%)	100.6 ± 3.3 (n = 20)	122.6 ± 2.8 (n = 8, P < 0.1%)
Mitochondrial fraction	0.164	85.9 ± 5.7 (n = 17, P < 2.5%)	118.4 ± 14.0 (n = 12)	83.7 ± 3.6 (n = 18, P < 0.1%)	128.0 ± 5.6 (n = 7, P < 0.5 %)
Microsome fraction	0.140	124.7 ± 6.4 (n = 17, P < 0.5%)	131.3 ± 12.0 (n = 12, P < 2.5%)	93.0 ± 4.4 (n = 18)	115.9 ± 11.4 (n = 8)
Supernatant fraction	0.350	108.4 ± 7.6 (n = 11)	120.8 ± 10.4 (n = 11)	99.0 ± 5.6 (n = 17)	164.5 ± 21.3 (n = 7, P < 2.5%)
Ultracentrifugal fraction from supernatant	0.065	156.0 ± 19.0 (n = 4)	107.4 ± 6.3 (n = 7)	116.4 ± 7.9 (n = 10)	145.4 ± 16.7 (n = 5)

* Mean ± standard error; n denotes number of observations and P the probability that the difference from the controls could be due to chance.

nuclei. Centrifugation was performed with an 'Angle 13' centrifuge (Measuring and Scientific Instrument Co.). The debris was homogenized and centrifuged twice more, and the combined supernatants further centrifuged (for 20 min., 12,000 g at extreme tip of tube) to sediment the 'large-particle' (mitochondrial) fraction, which was washed once. Further centrifugation, 20,000 g for 90 min., gave a microsome fraction, which showed a clear morphological difference from the mitochondrial fraction on electron micrographs (kindly prepared by Mr. F. W. Cuckow). The final supernatant fraction was, in some experiments, further centrifuged (90 min. at 145,000 g) to give an 'ultracentrifugal fraction'. Each fraction was freed from sucrose by dialysis in the cold, against water containing a trace of ammonium carbonate to maintain the pH slightly alkaline[5], and was freeze-dried on the following day.

As shown in Table 1, there was an increase in relative liver-weight in hypophysectomized rats, whether untreated or injected with growth hormone, in contrast with the decrease reported from Li's laboratory[2]. If the hypophysectomized rats were compared only with the controls fed *ad libitum*, no difference in liver-weight was evident. Comparisons in other respects showed no differences between controls fed *ad libitum* and pair-fed controls, which were therefore regarded as equivalent.

An increase in liver-weight also occurred in adrenalectomized rats given cortisone, although not in untreated adrenalectomized rats.

Hypophysectomy, with or without growth hormone, led to an increase in the yield of the freeze-dried microsome fraction; the same tendency was shown by the other cytoplasmic fractions, with the notable exception of the mitochondrial fraction, the yield of which was significantly depressed in the untreated hypophysectomized rats. A similar depression of mitochondrial yield was found with adrenalectomized rats, although not if cortisone had been given. Cortisone had the further effect of markedly elevating the yield of the supernatant fraction; this increase was not confined to the ultracentrifugal fraction.

Portions of each cytoplasmic fraction were treated with cold trichloracetic acid solution and then with lipid solvents, and the lipid extracts and residues separately analysed for total phosphorus. It is essentially valid to regard the residual phosphorus as entirely derived from ribonucleic acid. The results thus obtained (Table 2) show only one change in lipid phosphorus concentration—a fall in the case of the microsome fraction from hypophysectomized rats given growth hormone. But decreases in concentration of ribonucleic acid phosphorus are found with hypophysectomized rats in the case of both the mitochondrial and the microsome fractions, the fa in microsome ribonucleic acid phosphorus bein actually enhanced by growth hormone. On the othe hand, an increased concentration of ribonucleic aci phosphorus is found in the supernatant fraction (no primarily in the ultracentrifugal fraction derive therefrom) both with hypophysectomized rats give growth hormone and with adrenalectomized rats.

With the view of obtaining aqueous solutions o cytoplasmic proteins suitable for electrophoreti studies, samples of the cytoplasmic fractions othe than the supernatant fraction were treated wit n-butanol[6] and then with borate buffer. Crud comparisons of the protein patterns obtained afte paper electrophoresis showed no consistent hormona effects; but some interesting hormonal effects wer revealed by weighing the residue remaining after eac extraction. With the hypophysectomized rats give growth hormone, the residue from the butanol extrac tion was lowered in the case of the microsome an ultracentrifugal fractions, thus suggesting that th lipid content of these fractions was increased. Wit untreated hypophysectomized rats, the residu remaining after the further aqueous extraction (Tabl 2) was increased in the case of the mitochondria fraction but was lowered in the case of the microsom fraction. The values for hypophysectomized rat given growth hormone were lower, for all fraction studied (Table 2), than those for untreated hypophys ectomized rats, while adrenalectomy was withou significant effect.

Clearly, then, pituitary and adrenal hormone influence the yield and composition of the fraction derived from liver cytoplasm. Equivalent change have not been observed in the yields of the corre-sponding fractions from kidney, nor have intac female rats given growth hormone shown change such as occur in the liver of hypophysectomized rat given growth hormone. The fall in mitochondria yield after hypophysectomy might be attributable t loss of adrenocorticotrophin together with growt hormone, since adrenalectomy likewise depresses th yield. Recalculation of ribonucleic acid phosphoru in terms of body-weight shows a striking depression in untreated hypophysectomized rats in the case o the mitochondrial fraction, although not of the othe fractions, and also a significant depression in hypo-physectomized rats given growth hormone, in the case of the microsome fraction. On the other hand, the ribonucleic acid phosphorus of the supernatant is increased in hypophysectomized rats given growth hormone and in adrenalectomized rats; the lack of change in untreated hypophysectomized rats suggests that both adrenocorticotrophin and growth hormone influence, in converse directions, the ribonucleic acid

Table 2. COMPOSITION (mgm./100 mgm. FREEZE-DRIED FRACTION) OF LIVER FRACTIONS

Fraction	Constituent	Control rats (mean value)	Experimental rats (values as per cent of values for control rats)			
			Hypophysectomized	Hypophysectomized + growth hormone	Adrenalectomized	Adrenalectomized + cortisone
Mitochondrial fraction	Lipid phosphorus	0.63	105.2 ± 3.5 ($n = 17$)	99.9 ± 2.8 ($n = 13$)	93 ($n = 2$)	—
	Ribonucleic acid phosphorus	0.48	90.0 ± 4.6 ($n = 16$, $P < 5\%$)	89.9 ± 5.6 ($n = 11$)	115.0 ± 7.9 ($n = 5$)	90 ($n = 3$)
	Non-extractable material*	43	113.4 ± 4.1 ($n = 17$, $P < 0.5\%$)	88.5 ± 7.3 ($n = 14$)	84.7 ± 8.7 ($n = 7$)	—
Microsome fractions	Lipid phosphorus	0.88	92.7 ± 6.1 ($n = 18$)	84.9 ± 4.0 ($n = 15$, $P < 0.5\%$)	93 ($n = 2$)	—
	Ribonucleic acid phosphorus	0.65	86.4 ± 4.7 ($n = 16$, $P < 2.5\%$)	72.1 ± 6.1 ($n = 15$, $P < 0.1\%$)	115.8 ± 13.1 ($n = 4$)	101 ($n = 3$)
	Non-extractable material	48	89.3 ± 4.2 ($n = 17$, $P < 2.5\%$)	75.0 ± 4.9 ($n = 12$, $P < 0.1\%$)	99.0 ± 6.1 ($n = 7$)	—
Supernatant fraction	Lipid phosphorus	0.166	112.6 ± 6.9 ($n = 10$)	118.3 ± 14.9 ($n = 7$)	93 ($n = 3$)	—
	Ribonucleic acid phosphorus	0.223	105.5 ± 5.3 ($n = 12$)	141.0 ± 10.6 ($n = 10$, $P < 0.5\%$)	124.5 ± 5.9 ($n = 6$, $P < 1\%$)	125 ($n = 3$)
Ultracentrifugal fraction from supernatant	Lipid phosphorus	0.68	125.5 ± 11.6 ($n = 4$)	107.1 ± 11.2 ($n = 6$)	—	—
	Ribonucleic acid phosphorus	0.67	90.8 ± 7.8 ($n = 4$)	113.7 ± 6.8 ($n = 6$)	87 ($n = 1$)	87 ($n = 1$)
	Non-extractable material	45	99.8 ± 6.8 ($n = 4$)	76.3 ± 6.1 ($n = 6$, $P < 2.5\%$)	—	—

* Insoluble after extraction at room temperature with *n*-butanol and then with borate buffer (*p*H 9.2).

phosphorus of the supernatant. It is, however, paradoxical that administration of cortisone to adrenalectomized rats did not reduce the yield or ribonucleic acid phosphorus content of the supernatant fraction; the yield was actually increased by cortisone. Lowe and Williams[7] observed a striking shift of ribonucleic acid from the mitochondrial and microsome fractions to the supernatant fraction, and especially to the ultracentrifugal fraction, on giving cortisone to intact rats. Since, however, cortisone was given at the enormous dosage of 25 mgm. a day, their results may have little bearing on those now obtained. But an analogous rise of the ribonucleic acid in the supernatant fraction has been observed with rat liver following hypoxia or shock[8].

The decreased extractability of the mitochondrial fraction in untreated hypophysectomized rats could be due merely to lack of growth hormone; but in the case of the microsome fraction, if not of the ultracentrifugal fraction, it appears that the change in extractability cannot be explained merely in terms of growth hormone alone or of growth hormone together with adrenocorticotrophin. The same conclusion arises from the finding[9] that the number of particles in the mitochondrial fraction is not significantly altered by hypophysectomy alone or by adrenalectomy, but is increased in hypophysectomized rats given growth hormone.

If the growth-hormone treatment indeed enhanced protein synthesis in the liver, one might have predicted a rise rather than a fall in microsome ribonucleic acid, for it is currently believed that protein synthesis occurs particularly in the microsomes and is linked in some way with ribonucleic acid[10,11]. It is possibly relevant that microsome protein synthesis is favoured by the presence of non-dialysable material[10] which might, under the present conditions, remain unsedimented. There is, of course, the possibility that ribonucleic acid could escape from mitochondria or microsomes during their isolation in consequence of an increase in permeability, and thus appear in the supernatant fraction.

In extending this preliminary investigation, it will be desirable to employ more refined centrifugation procedures. There is now ample evidence in the literature that mitochondrial and microsome fractions as now prepared are quite heterogeneous; thus, the 'mitochondrial' ribonucleic acid is located largely in particles composing the so-called fluffy layer. Another aspect which warrants attention is the effect of hormones on the turnover-rate of the ribonucleic acid in the different cytoplasmic fractions and also of nuclear ribonucleic acid, the amount of which is apparently influenced, in common with that of cytoplasmic ribonucleic acid, by hypophysectomy and by growth hormone[3].

Added in proof. When liver fractions are made extractable by treatment of cytoplasmic preparations with *n*-butanol in aqueous medium as recently described[12] rather than in the dry state, labile proteins may become denatured.

Acknowledgment is made to the British Empire Cancer Campaign for the award of a Junior Fellowship, to Prof. Alex Haddow for general encouragement, to Mr. I. Martin for technical assistance, to Dr. S. L. Steelman (of Armour and Co., Chicago) for providing growth hormone, and to Sir John Taylor (of the Medical Research Council) for providing cortisone acetate. Financial support was derived from grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

[Nov. 12

[1] Schneider, W. C., *J. Biol. Chem.*, 176, 259 (1948).

[2] Geschwind, I., Li, C. H., and Evans, H. M., *Arch. Biochem.*, 28, 73 (1950).

[3] Di Stefano, H. S., Bass, A. D., Diermeier, H. F., and Tepperman, J., *Endocrin.*, 51, 386 (1952).

[4] Reid, E., *Cancer Research*, 14, 249 (1954).

[5] Smith, H., Keppie, J., and Stanley, J. L., *Brit. J. Exp. Path.*, 34, 477 (1953).

[6] Morton, R. K., *Nature*, 166, 1092 (1950).

[7] Lowe, C. U., and Williams, W. L., *Proc. Soc. Exp. Biol. and Med.*, 84, 70 (1953).

[8] Drochmans, P., *Arch. Biol.*, 51, 475 (1947). Gavosto, F., and Movson, F., *Experientia*, 9, 263 (1953).

[9] Greenbaum, A. L., Slater, T. F., and Reid, E., *Nature* (in the press).

[10] Siekevitz, P., *J. Biol. Chem.*, 195, 549 (1952). Zamecnik, P. C., and Keller, E. B., *ibid.*, 209, 337 (1954).

[11] Allfrey, V., Daly, M. M., and Mirsky, A. E., *J. Gen. Physiol.*, 37, 157 (1953). Gale, E. F., and Folkes, J. P., *Nature*, 173, 1223 (1954). Brachet, J., *Nature*, 174, 876 (1954). Koritz, S. C., and Chantrenne, H., *Biochim. Biophys. Acta*, 13, 209 (1954).

[12] Adjutantis, G., *Nature*, 174, 1054 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Age Measurements on a Pegmatitic Mica from the Rhodesian Shield

IN the course of a series of determinations by the rubidium-87 → strontium-87 method of the ages of pegmatitic micas, it has been found that the method of separating and sampling such materials involves a possible source of error which we feel should be known to workers in this field and to those who prepare and select material for them. The effect is illustrated by measurements on a lepidolite from Pope's Claim, near Salisbury, Southern Rhodesia, of which the hand sample consists of a roughly elliptical 'book' of mica with axes 6 in. and 4 in and 1½ in thick The book contains three sharply differentiated types of mica (*a*) purple biaxial ($2V \approx 30°$), (*b*) greenish-white biaxial ($2V \approx 40°$) and (*c*) purple uniaxial The uniaxial mica lies between the two biaxial forms and in two isolated patches at the edge of the hand sample. The boundaries between the micas are perpendicular to the plane of the mica sheets and penetrate the full thickness of the book

Subsamples from the three zones, after the rejection of a few outer sheets, were weighed and dissolved in hydrofluoric acid and perchloric acid and made up as standard solutions of 100 c c in approximately $3N$ hydrochloric acid The concentrations of rubidium-87 and radiogenic strontium-87 were then determined by solid-source mass-spectrometric measurements on aliquot portions of these solutions using isotope dilution techniques The mass spectrometer resolution was in all cases around 200 The methods of separation of rubidium and strontium were based on those described by Aldrich *et al* [1] and will be described in detail elsewhere Care was taken to avoid contamination and to obtain the highest accuracy from the isotope dilution method.

The concentrations of rubidium-87 and radiogenic strontium-87 found in the three types of mica are given in Table 1 and show a wide variation The ages found from them are, however, all in satisfactory agreement and confirm the great age previously found by this method and others for the Rhodesian Shield

It is clear that if the necessary four determinations of the rubidium-87 and radiogenic strontium-87 contents and isotopic abundances of this material had not been made on the same separated subsamples of *a*, *b* and *c* the age results might have been very much in error Even crushed and well-mixed samples of the 'book' as a whole would have to be quite homogeneous to ensure that no great spread occurred in the results The errors expressed in these ages have been evaluated so as to give the maximum range of the determinations made On other rocks there ar indications of the need for a full statistical examination before a true significance can be attached t individual ages, and this study is now in progress

Table 1 HAND SAMPLE FROM POPE'S CLAIM, NEAR SALISBURY, SOUTHERN RHODESIA

Mica	$\left(\frac{^{87}\text{Sr}}{\text{Total Sr}}\right)$rock	$^{87}\text{Rb}_0$ (mgm / gm)	$^{87}\text{Sr}^*$ (μgm / gm)	Age in years $\times 10^{-9}$
(*a*) Purple biaxial	0 952	8 99	266	$2\ 69^{+0\ 115}_{-0\ 061}$
(*b*) Green biaxial	0 713	4 77	148	$2\ 82^{+0\ 053}_{-0\ 118}$
(*c*) Purple uniaxial	0 986	7 12	201	2 57

We should also like to direct attention to a poin of importance in the use of isotope dilution methods Any small error, whether due to contamination or t measurement, may be reflected as a large error i the derived age if the relative amounts of rock an added isotopic diluent are not carefully chosen. Th choice will depend upon the isotopic abundances i the rock and added diluent, and the particular isotopi ratios chosen for finding the concentrations

Finally, it may be pointed out that the results i Table 1 show that if ionic migration has taken plac in this material, it has been such as to preserve th same ratio of rubidium-87 to radiogenic strontiu in all three zones, which seems unlikely

We wish to thank Dr M. A. Tuve and Dr L. T Aldrich, of the Department of Terrestrial Magnetism Carnegie Institution of Washington, for help in th initiation of our programme of work in this field

G. D L SCHREINER
R. T JAMIESON
B F. J. SCHONLAND*

Nuffield Geochemical Unit,
Bernard Price Institute
for Geophysical Research,
University of the Witwatersrand,
Johannesburg. Jan. 18.

---

* Present address Atomic Energy Research Establishmen Harwell

[1] Aldrich, L T , Doak, J B , and Davis, G L , *Amer J Sci* , 251, 37 (1953)

Origin of Nickel in Deep-Sea Sediments

Pettersson and Rotschi[1] have suggested tha cosmic dust may be in part the source of the nicke found in Pacific deep-sea cores. In these cores nicke occurs in amounts up to 0 08 per cent, and it wa stressed that this is considerably higher than th average value of 0 008 per cent given by Sandel and Goldich[2] for the uppermost crust of the earth Öpik[3] concurred with the view that the nickel i largely of cosmic origin, and concluded that th "zodiacal light as interpreted by van de Hulst[4], an the cosmic nickel revealed by the Swedish Deep-Se Expedition are produced mainly by primordial dus of the solar system spiralling towards the sun i orbits which are nearly circular". Buddhue[5] estimate from the amounts of cosmic dust brought down b rain that the annual fall of magnetic particles ove the earth's surface is 35–70 × 10^6 kgm., while Norri and Hogg[6], from the weight of magnetic particle falling on trays exposed in north-west Canada, stat that the annual fall per square kilometre amount to less than half a kilogram. Support[3] for a cosmi origin of nickel was also given by the similarit between van de Hulst's figure for the space densit of the zodiacal light cloud of primordial dust an that required to account for the nickel content o deep-sea clays

Pettersson and Rotschi were careful to point ou that confirmation of meteoritic origin of the nicke in deep-sea sediments was necessary, and suggeste that this might be obtained if an analysis for th platinum metals could be made in these sediments

Although we have detected palladium, using a radioactivation method, even in some Atlanti globigerina ooze samples, its presence does not i

Table 1 RATIOS INVOLVING NICKEL, COBALT AND COPPER

Material	Number of samples examined	Ni Co Average ratio	Ni Co Range	Ni Cu Average ratio	Ni Cu Range	Cu Co Average ratio	Cu Co Range
Red clay	11	3 1	1 6–7 1	0 85	0 4–1 3	3 7	1 3–5 7
Globigerina ooze	33	4 1	1 8–7 0	0 77	0 4–1 6	5 4	2 0–11 0
Manganese nodules	7	4 3	1 4–6 5	1 2	0 4–2 4	4 3	0 6–7 0
Oceanic rocks	9	2 3	1 4–4 3	1 6	0 2–3 1	2 7	0 7–6 9
Average for igneous rocks (ref 7)		3 5		1 1		3 0	
Meteorites (stones and stony-irons)	9	22 7	12–52	100	75–119*	0 24	0 2–0 4*
Average for meteorites (ref 7)		13 1		92		0 14	

* Omitting Khor Temiki, which gave Ni Cu 11 7 and Cu Co 2 0

our opinion confirm the meteoritic origin of the nickel, as the ratio nickel to palladium is approximately the same ($\sim 10^4$) for both average meteorites and igneous rocks[7]. (*Added in proof.* Similar reasoning has been applied in the case of manganese nodules[8].) Much more pertinent ratios for information about meteoritic origin would seem to be those of nickel/cobalt, nickel/copper and copper/cobalt, which are given as 13 1, 92 and 0 14 for meteorites, and 3 5, 1 1 and 3 0 for igneous rocks respectively[7].

We have determined these three elements, by radioactivation methods, in representative samples of globigerina ooze, red clay and oceanic rocks from the Atlantic, Pacific and Indian Oceans, and the average ratios with their range are given in Table 1 Some further analyses of manganese nodules and stony meteorites, using the same methods, are included. Although in one batch of globigerina ooze samples from a short pilot core there seemed to be a possible significance in that the nickel/cobalt ratio increased with increasing nickel content (the other two ratios did not change significantly), the many further samples of globigerina ooze and red clay did not show any such correlation

From this fact and the evidence given in Table 1, it would appear that there is little significant contribution of meteoritic material to deep-sea sediments, unless some remarkable differential behaviour of the three elements nickel, cobalt and copper has taken place.

Acknowledgment is made to Mr. A J. Wood and Mr. D. Mapper for their invaluable assistance in the analyses. Details of this work will be submitted for publication elsewhere.

A. A. SMALES
Atomic Energy Research Establishment,
Harwell, Berks.

J. D. H. WISEMAN
British Museum (Natural History),
London, S W 7. Nov. 18

Pettersson, H , and Rotschi, H , *Geochim et Cosmochim Acta*, **2**, 81 (1952)
Sandell, E B , and Goldich, S S , *J Geol* , **51**, 181 (1943)
Öpik, E I , *Irish Astron J* , **1**, No 5, 145 (1951).
van de Hulst, H C , *Astrophys J* , **105**, 471 (1947).
Buddhue, J D , Univ New Mexico Pub Meteoritics, No 2, 7 (1950)
Norris, K D , and Hogg, F S , *Astron J* , **54**, 192 (1949)
Rankama, K , and Sahama, T G , "Geochemistry", 39 (University of Chicago Press, 1950)
Goldberg, E , *J Geol* , **62**, 254 (1954)

Snowfall and Temperature on a California Mountain

A SNOWFALL and temperature analysis has been ompleted for six winter seasons (1948–54) on White Mountain, California (elevation 10,600 ft.). Snowfall and the temperature maxima and minima were measured for every 24 hr. at 0800 Pacific Standard Time. Fig. 1*a* shows the total snowfall as a function of the mean air temperature of the day on which the snow fell An interesting peak occurs at – 11° C., just as Bossolasco reports[1] for the case of snowfall at Weissfluhjoch. Rau's laboratory work[2] indicates that the majority of atmospheric nuclei induce freezing between – 10° and – 12° C Silver iodide begins its activity as a freezing nucleus in the laboratory at – 4° C. [3], and at this point Fig. 1*a* shows another peak. Bossolasco has also mentioned that Mason and Ludlam[4] report this point as a secondary maximum in laboratory frequency of atmospheric freezing nuclei. However, it is believed that the – 4° C. peak may be related to large cloud-seeding experiments utilizing silver iodide smoke carried on in the Sierra Nevada Mountains about thirty miles up wind to the west[5] during the seasons 1951, 1952 and 1953 Vonnegut[6] expected that unusual and far-reaching effects must be expected in the case of such seedings, since silver iodide is much more active than any known natural ice nucleus.

In considering the first three winters alone, we find no significant peaks at temperatures warmer than – 11° C. Carbon dioxide ('dry ice') seeding was being carried on in the area during these winters[7]. In a plot of the frequency of snowfall (when amounts were 0 10 in. or more) as a function of mean air temperature (see Fig 1*b*) the same two peaks of Fig. 1*a* appear, with the – 4° C. maximum depending entirely on the second half of the six-season period There is no peak in this latter region for the first three winters

I am indebted to the University of California for the weather observations and to the Office of Naval

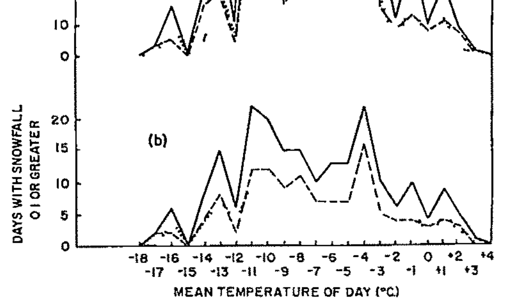


Fig 1 Relationship between air temperature in degrees centigrade (mean temperature of day) and (*a*) total snowfall , (*b*) number of days with snowfall of 0 1 in or greater

Research for the establishment and continued support of the White Mountain Research Station

CHARLES L D'OOGE

Michelson Laboratory,
U.S. Naval Ordnance Test Station,
Inyokern,
China Lake, California.

[1] Bossolasco, M, *Nature*, **174**, 362 (1954)

[2] Rau, W, *Schr deutsch Akad Luft*, *Berlin*, **8**, 65 (1944)

[3] Schaefer, V J, "Compendium of Meteorology", 224 (Amer Met Soc, Boston, 1951)

[4] Mason, B J, and Ludlam, F H, "Reports on Progress in Physics", **14**, 170 (1951)

[5] Elliott, R D, and Strickler, R F, *Bull Amer Met Soc*, **35**, No 4, 171 (April 1954)

[6] Vonnegut, B, *J App Phys*, **18**, 593 (1947).

[7] Hall, F, Henderson, T J, and Cundiff, S A, *Bull. Amer Met. Soc*, **34**, No 3, 111 (March 1953)

Newtonian Cosmology

THE late E. A Milne[1] found a Newtonian analogue of a particular relativistic model of the expanding universe He and I then showed[2] that there are Newtonian analogues of all the pressure-free relativistic models and, moreover, that the equations describing their behaviour are formally identical with the relativistic equations As we stated, there are differences regarding the interpretation of the equations However, our view that the work helps in the physical understanding of the relativistic treatment has been borne out by subsequent developments D Layzer[3] has recently criticized our work and asserts that "it is incompatible with the Newtonian conception of gravitation which it tries to incorporate". H. Bondi[4] regards it as not strictly compatible with Newtonian dynamics, but he gives reasons for the results being nevertheless significant

The fact is that our work is rigorously in accordance with classical kinematics, dynamics and gravitation, when it is correctly formulated. The reasons may be briefly stated here (and will be given more fully elsewhere)

Let F be a Newtonian frame of reference, t Newtonian time, R a function of t only Let there be given a finite distribution of pressure-free, gravitating fluid S, spherically symmetric about a point O fixed in F Then the work of Milne and myself shows that the following behaviour of S is possible on strictly classical theory

Velocity of a particle P having position vector $\mathbf{q}$ in F relative to O as origin is.

$$d\mathbf{q}/dt = (R'/R)\mathbf{q}, \quad (R' \equiv dR/dt) \tag{1}$$

the motion being therefore radially symmetrical with respect to O, the density ρ is a function of t only, given by

$$\rho = \rho_0/R^3, \quad (\rho_0 = \text{constant}) \tag{2}$$

the density being therefore uniform at each epoch, the function R is any solution of the equation

$$R^2R'' = -\frac{4}{3}\pi G\rho_0, \quad (G = \text{gravitational constant}) \tag{3}$$

the function R being therefore independent of the overall extent of the fluid

Suppose, then, that the system is behaving in this way, R being any particular solution of (3). Its behaviour is therefore once and for all in strict accordance with classical theory

Now let A be any given particle of the fluid wit position vector $\mathbf{a}$ relative to O Let G be a referenc frame in which A is fixed, G being not rotating rela tive to A. Let $\mathbf{q}_A$ be the position vector of P in relative to A as origin. Then (1), with its particula case $d\mathbf{a}/dt = (R'/R)\mathbf{a}$ and the vector relation $\mathbf{q}_A =$ $\mathbf{q} - \mathbf{a}$, gives

$$d\mathbf{q}_A/dt = (R'/R)\mathbf{q}_A \qquad (4$$

Thus the motion of the fluid in G relative to A the same as its motion in F relative to O. Th depends upon classical kinematics only, and no upon assuming the frame G to be Newtonian, G not Newtonian.

The boundary of the fluid is not symmetrical abou A But we have seen that the motion of the flu is independent of its extent This we can take to b arbitrarily great and, in particular, large compare with the range of observation of any observer sup posed moving with the fluid. Using his own referenc frame, every such observer will then give exactl the same description of 'the universe' at the sam epoch t Or, rather, this is true save for observe relatively close to the boundary of the system; th proportion of these exceptional observers can be mad arbitrarily small by taking the extent of the syste sufficiently large.

We could let the extent of the system tend t infinity and then apparently obtain the equivalenc as applying to all observers moving with the fluid This is, in effect, what Milne and I did But it not a meaningful 'limit' It is, however, complete adequate for our purpose, and mathematically prefe able, to keep to an arbitrarily large system. Fo then there is no question of departing from a stric Newtonian treatment

As we showed, equations (2) and (3) lead to result formally identical with those of relativistic cosmolog and having the same degree of generality. Therefor if we seek the Newtonian analogue of the gener relativistic model, it exists, it is the system we con template, and, as the present discussion shows, it strictly Newtonian. The validity of this result is th concern of this communication, the interest or valu of the result need not be considered here

Layzer considers the work to be invalid because h fails to get the same result by a different mathematic treatment applied to a different system. Of th system, he affirms that the density is uniform a any epoch and the gravitational intensity vanishe everywhere. Consequently, it is not a Newtonia system unless the density is zero The impossibilit of getting a Newtonian system by such a procedur is well known, what Milne and I did was expressl to find a different procedure.

It must be added that, from some work of Bondi's Layzer[3] also infers a property of Einstein's law gravitation that seems to substantiate Milne's an my interpretation However, so far as a 'Newtonia treatment of an unbounded system is concerne Layzer has directed attention to a genuine difficulty

W H. McCREA

Royal Holloway College,
Englefield Green,
Surrey

Nov. 8.

[1] Milne, E A, *Quart J Math*, **5**, 64 (1934)

[2] McCrea, W H, and Milne, E A, *Quart J Math*, **5**, 73 (1934) see also McCrea, W H, "Rep Prog Phys," **16**, 321 (1953)

[3] Layzer, D, *Astro J*, **59**, 268 (1954)

[4] Bondi, H, "Cosmology", 78 (Camb Univ Press, 1952)

[5] Bondi, H, *Mon Not Roy Astro Soc*, **107**, 410 (1947)

Infection of Wheat by Loose Smut, *Ustilago tritici* (Pers.) Rostr.

THE life-history of this disease was first investigated at the beginning of this century[1], and it has been generally accepted that infection takes place through the stigmas at flowering time. A few workers[2] considered, however, that the fungus may also penetrate directly through the ovary wall. In 1934 [3] this latter phenomenon was actually reported, and in 1942 [4] infection both down the style and through the ovary wall was said to occur. Very little appears to have been published on the path of the fungus from the nside of the ovary wall to infection of the embryo proper since it was first described by Lang[1].

In 1953 and 1954, ears of susceptible wheat varieties (Hybrid 46, Vilmorin 27) were inoculated at anthesis by the partial vacuum method[6]. Ears were then fixed at intervals after inoculation and the path of infection investigated. Surface preparations of the various issues of the developing grain and serial microtome sections were used. More than sixty grains were examined by one or other method.

No evidence of infection down he style has been found; mycelium was never present at he apex of the grain in the tylar area. Entry of the fungus nto the ovary was found to take lace through the ovary wall pericarp). Penetration of any art of the wall seems to be ossible. Most frequently it was een on the shoulders of the rain just below the lowest of the airs which abound at the apex f the grain.

An appressorium was formed t the point of penetration, and he usual peg-like structure was resent at the point of entry. Funnels and sheathing of internal mycelium (Fig. 1) were often een[7]. In the pericarp, the mycelium was mainly intracellular. After about ten days, he fungus had reached the testa rea and begun to permeate his region, where it was again hiefly intracellular. Mycelium as rarely found in the endosperm, and even where present extended only to the depth f a few cells. Over the embryo dorsal side of the grain) the ycelium grew from the testa hrough the aleurone layer and ntered the scutellum (Fig. 2). his stage was reached after bout thirty days. The mycelium developed profusely in he scutellum and passed to the embryo proper, but did not penetrate the plumule or radicle.

Infection of the scutellum and embryo from mycelium present on the ventral side of the grain has not been seen (cf. ref. 5).

In July 1954 ears were picked at random in a farm crop of badly infected Hybrid 46 wheat in Sussex and fixed. Examination of a number of grains has shown that spores were frequently present on the wall of the developing grain, and mycelium and penetration points were present on the pericarp of each grain having an infected embryo. The testa also of infected grains contained mycelium.

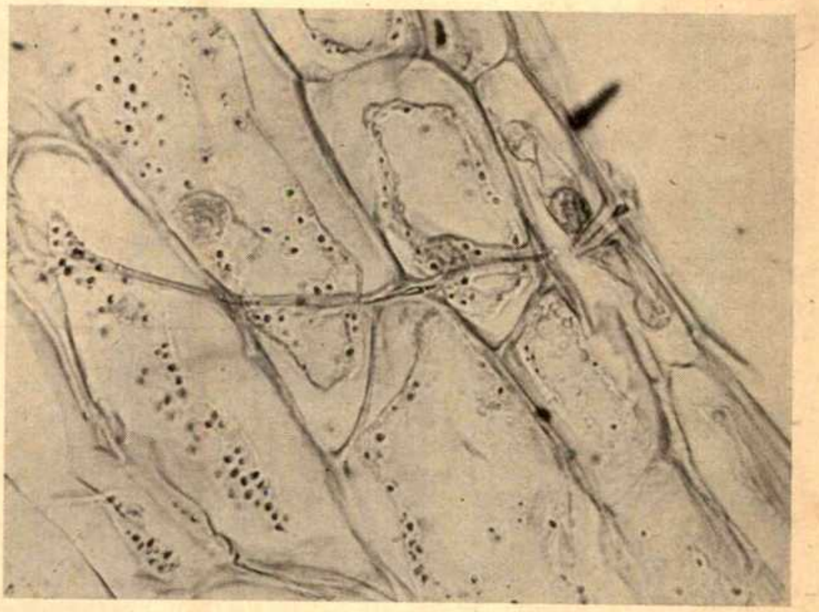


Fig. 1. Longitudinal section of pericarp of developing wheat grain 18 days after inoculation, showing funnel at point of entry and sheathing of the intracellular mycelium. × 675

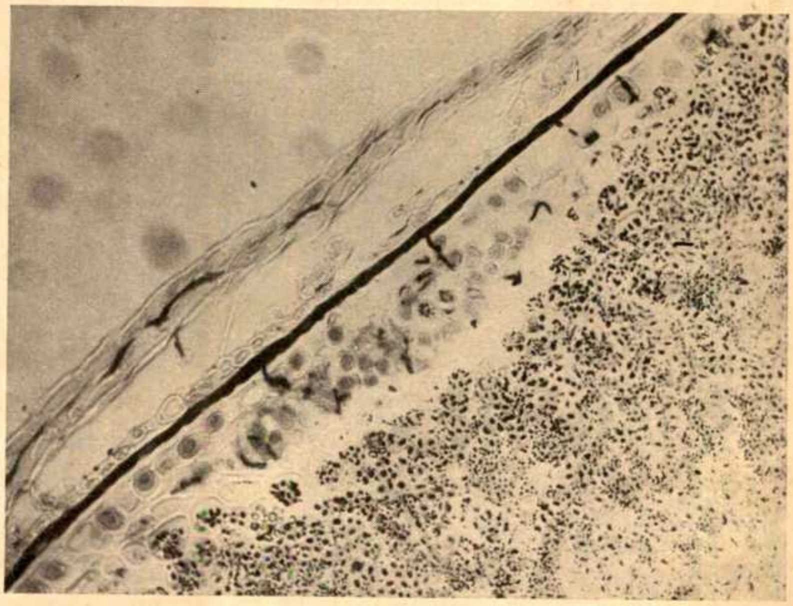


Fig. 2. Longitudinal section of developing wheat grain near edge of scutellum showing mycelium entering scutellum from testa, 33 days after inoculation. × 560

A full account of these observations will appear elsewhere.

C. C. V. Batts

National Institute of Agricultural Botany,
Huntingdon Road,
Cambridge.
Nov. 10.

---

[1] Maddox, F., *J. Council Agric.*, 4 (1896). Brefeld, O., *Nachr., Kl. Landw., Berl.*. No. 466 (1903). Lang, W., *Zbl. Bakt.*, Abt. 2, 25, 86 (1910).

[2] McAlpine, D., "The Smuts of Australia" (Melbourne, 1910). Freeman, E. M., and Johnson, E. C., Bull. U.S. Bur. Plant Indust., 152 (1909).

[3] Ruttle, M. L., N.Y. St. Agric. Exp. Sta., Tech. Bull., 221 (1934).

[4] Vanderwalle, R., Bull. Inst. Agron. Gembloux, 11, 103 (1942).

[5] Gaumann, E., "Principles of Plant Infection", 108 (London, 1950).

[6] Oort, A. J. P., *Phytopath.*, 29, 717 (1939).

[7] Western, J. H., *Ann. App. Biol.*, 23, 245 (1936). Rice, M. A., *Bull. Torrey Bot. Club.*, 54, 63 (1927). Churchward, J. G., *Ann. App. Biol.*, 27, 58 (1940).

Campestrin, the Antibiotic of *Psalliota campestris*

Atkinson[1] has obtained an antibiotic from *Psalliota xanthoderma* which she has recently named 'psalliotin'. In 1946 and 1949 she gave an account of the potency of this antibiotic substance against Gram-negative and some Gram-positive bacteria. So far, the substance awaits purification. She advocates darkness or yellow light during the extraction process, as she has found that the antibiotic substance in crude form is very sensitive to different types of light.

In 1952 and 1953 I published[2] a somewhat detailed account of the antibacterial action of *Psalliota campestris* (L.) Fries, the common edible mushroom. This is readily available in Calcutta markets during the rainy season. *Psalliota xanthoderma* is also edible; but it is regarded as somewhat poisonous and toxic to some persons according to the publication of the Ministry of Agriculture and Fisheries, Great Britain, where it is recorded as: "it is suspicious in character and is known to have caused illness in some cases". Elaborate animal experiments showed that the crude filtrate of *Psalliota campestris* is completely non-toxic. Clinical trials in typhoid cases in the Carmichael Medical College Hospital gave encouraging results. Partial concentration of this crude filtrate was carried out by absorption on activated charcoal ('Darco' brand) and subsequent elution with 80 per cent ethyl alcohol. This concentrated solution showed much higher potency both by the agar-cup method and serial dilution test. It was also used with very favourable results in 1 c.c. ampoules administered intramuscularly in seven severe typhoid cases in the typhoid ward of the Hospital, supplemented by oral administration of the crude filtrate. Attempts are being made to purify it further. I propose to name the active substance 'campestrin', derived from the local *Psalliota campestris*.

I am grateful to the Council of Scientific and Industrial Research, Government of India, for a research grant to carry out this work.

S. R. Bose

Botanical Laboratory,
Carmichael Medical College,
Calcutta.
Nov. 8.

---

[1] Atkinson, N., *Nature*, 174, 598 (1954); *Aust. J. Exp. Biol.*, 24, 169 (1946); *Med. J. Aust.*, 1, 605 (1949).

[2] Bose, S. R., *J. Sci. Indust. Res.*, 11B, 159 (1952); *Arch. für Mikrobiol.*, 18, 349 (1953).

Germination of Chlamydospores in the Endogonaceae

No reports have been published of the germination of zygospores or chlamydospores in the Endogonaceae. Thaxter[1], writing in 1922, stated that no success had followed attempts to germinate the spores in any member of the group, and he mentioned his own unsuccessful efforts with the zygospores of *Endogone pisiformis* Link.

Since September 1953, repeated attempts have been made to germinate chlamydospores of *E. macrocarpa* (Tul.), Tulasne and *E. microcarpa* (Tul.), Tulasne, and zygospores of *E. lactiflua* Berk. No success has been obtained with the latter; but chlamydospores of both the former species have been observed to germinate on plain agar.

Spores of *E. macrocarpa* from certain fruit-bodies among those collected in the autumn of 1953 were successfully germinated. Some germinated at once and others after an interval of several months, during which time they were stored in soil. Those of *E. microcarpa*, collected at the same time, were first observed to germinate when plated out in the following spring. Spores from fruit-bodies of *E. macrocarpa* collected in 1954 have failed to germinate when placed under similar conditions, but germination of *E. microcarpa* spores has been observed at intervals during the year.

The spores which germinated were derived only from a few fruit-bodies among numerous collections, and often represented but a small proportion of the spores in those fruit-bodies. No stimulation of germination was achieved by a wide range of treatments, including alternate wetting and drying, mechanical rupture of the spore wall and exposure to extremes of heat and cold. It seems likely, therefore, that the percentage germination is a function rather of the state of the fruit-body than of the environment.

The mode of germination of the chlamydospores is illustrated in Fig. 1. The hyphæ which grow out from the spores are very similar in the two species,

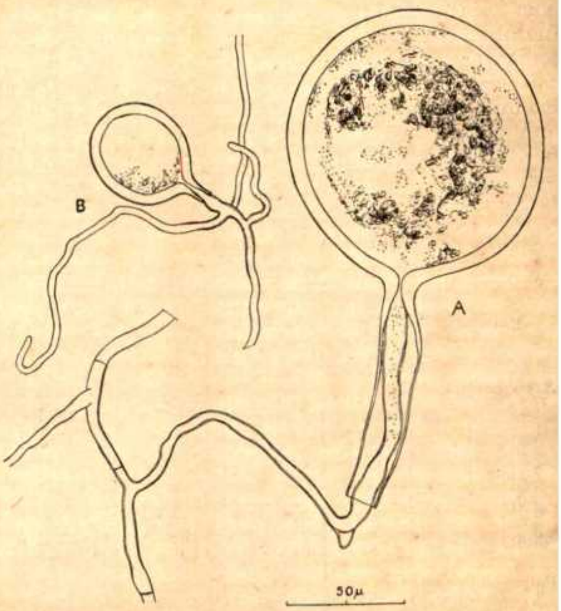


Fig. 1. Germinating chlamydospore of (*A*), *E. macrocarpa*, (*B*), *E. microcarpa*

articularly with regard to the mode of branching he new hypha emerges from the stump of the old ne on which the spore was produced. It grows lowly and occasionally gives off branches which may nastomose with nearby hyphæ The formation of erminal or intercalary chlamydospores on the nycelium so produced has sometimes been observed It is hoped to publish a fuller account elsewhere.

R. M. Godfrey

Department of Botany,
University of Bristol.
Nov 12

Thaxter, R, *Proc Amer Acad Arts Sci*, 57, 291 (1922)

A Polyhaploid Plant of *Solanum polytrichon* Rydb.

S polytrichon Rydb. and *S. stoloniferum* Schlechtd. re two related tetraploid species, $2n = 48$, in the ongipedicellata group of tuberous *Solanums*. Using e former as female parent, Dodds (unpublished ork) obtained a good seed set in a cross between em, but only one seed germinated. This plant had e chromosome number $2n = 24$, suggesting that it ught be a polyhaploid of *S polytrichon*, having isen by haploid parthenogenesis. The plant was lorotic and this fact is evidence in support of a arthenogenetic origin, as the parental plant of *S olytrichon* (Commonwealth Potato Collection No 30.1) used was known to be heterozygous for a ngle recessive gene for chlorosis (Dodds, unpublished ork). The polyhaploid was also smaller and slower owing than the normal plant. Table 1 shows the rminal leaflet index and stomatal length of the lyhaploid compared with those of *S. polytrichon* P.C. 2330 1) and its normal and chlorotic segre-tes. A least-squares analysis of the data in Table 1 owed the reduction in both the leaflet index and omatal length of the polyhaploid to be significant, d to be a direct consequence of the halved chromo-me number and not of the fact that the plant was lorotic Similar reductions in leaf index and omatal length were observed in polyhaploid *S missum* Lindl. by Howard and Swaminathan[1], and so in the 24-chromosome plant, supposedly haploid, m the cross *S chaucha* $2n = 36 \times$ *S. tuberosum* $= 48$, Lamm[2]. Narrow leaflets (low leaf index) em to be a valuable morphological character for stinguishing *Solanum* polyhaploids

Table 1

Material		Chromosome number, $2n =$	Mean terminal leaflet index ± *S EM*	Mean stomatal length* ± *S EM*	Habit
polytrichon C P C 2330 1		48	82 0±1 57	23 7 ±0 32	Normal
Segregates of *S polytrichon* C P C 2330 1	1	48	82 7±1 39	20 9 ±0 47	
	2	48	90 0±1 49	21 3 ±0 37	
	3	48	87 3±2 53	22 5 ±0 42	
	4	48	86 3±2 99	21 4 ±0 37	Chlorotic
	5	48	94 4±1 85	21 4 ±0 30	
	6	48	92 1±3 07	19 4 ±0 35	
	7	48	91 5±1 67	20 4 ±0 30	
olyhaploid *S polytrichon*		24	76 8±1 44	15 72±0 31	

* In micrometer eyepiece units, 1 unit = 1 4 μ

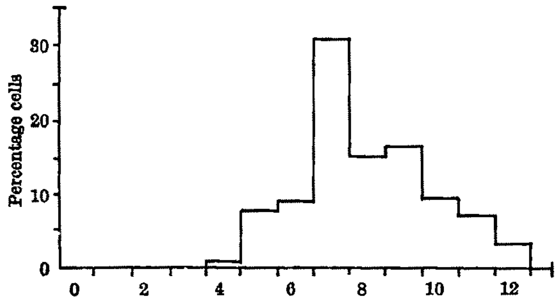


Fig 1. Bivalents per cell in polyhaploid *S polytrichon*

At meiosis in *S. polytrichon* (C.P.C. 2330 1), 24 bivalents are regularly produced, whereas in the polyhaploid there is a considerable reduction in bivalent formation. In an analysis of seventy-four cells at metaphase I, the mean number of bivalents was 7·9 ± 0 55 The range and frequency of bivalents per cell are shown in Fig. 1.

This behaviour contrasts with that in normal diploid *Solanums*, where complete pairing is invariably the rule. Also in the haploid *S. tuberosum* L studied by Ivanovskaja[3], eleven to twelve bivalents were formed, while the 24-chromosome plant reported by Lamm[2] showed almost complete pairing at meiosis.

Reduction in bivalent frequency per cell has been shown to be a reliable indication of genomic differentiation in polyhaploid *S. demissum* (Marks[4]). Consequently, it is also reasonable to interpret the reduced bivalent frequency in polyhaploid *S polytrichon* as indicating differences between its two sets of twelve chromosomes This implies that *S polytrichon* itself is essentially allotetraploid. A similar conclusion has been reached by Swaminathan[5] for other species in the group Longipedicellata. The polyhaploid rarely comes to full flower, and even then it is completely sterile. It produces tubers quite readily.

G. E. Marks

Agricultural Research Council
Potato Genetics Station,
Huntingdon Road,
Cambridge.
Oct. 22.

[1] Howard, H W, and Swaminathan, M S, *Genetica*, 26, 281 (1953)

[2] Lamm, R, *Hereditas*, 24, 391 (1938)

[3] Ivanovskaja, E V, *C R (Doklady) Acad Sci, U R S S*, 24, 517 (1939)

[4] Marks, G E, *J Genet* (in the press)

[5] Swaminathan, M S., and Howard, H W, *Bibliographica Genetica*, 16, 1 (1953)

Heterogeneity of Date Fruits

When I was washing a population of date fruits collected from one and the same palm tree, variety "Hayyani", I noticed that some fruits floated to the surface of the water while others sank to the bottom of the vessel. I then analysed samples of both floating and sunken fruits and found much smaller sugar content in the former than in the latter. It was therefore thought advisable to investigate the possibility of floating such fruits in water and also in aqueous solutions of sodium chloride as a criterion for segregation of such population into more or less homogeneous batches with regard to their sugar con-

Determined matter	Analysis of the fruits floating on						Fruits sunk in 10% NaCl
	Dist water	2% NaCl	4% NaCl	6% NaCl	8% NaCl	10% NaCl	
Dry matter	24 45	27 15	29 16	30 22	32 45	34 55	39 40
Red sugars	6 14	6 22	6 11	5 93	6 09	6 35	6 27
Sucrose	5 03	7 22	8 84	9 47	12 40	15 81	17 75
Total sugars	11 17	13 44	14 95	15 40	18 49	33 16	24 02

tents This was done by putting the whole fruit population in a big vessel containing distilled water and then collecting all the fruits that floated as one batch , the sunken fruits were afterwards put in aqueous solutions containing 2, 4, 6, 8 and 10 per cent pure sodium chloride, and in each case the floating fruits were collected, washed with distilled water and finally analysed (after excluding the seeds), together with the last batch which sank in the 10 per cent sodium chloride solution.

The accompanying table shows the dry matter as well as the sugar content of each batch calculated in terms of grams per 100 gm. fresh weight of the fruits.

It appears clear from the table that although the population of the date fruits was collected from the same tree and at the same time, yet the fruits varied enormously in their dry-weights, the essential variation being in their sugar contents, especially the sucrose fraction. The fruits that floated on distilled water showed smallest dry-weight and also smallest sucrose content, while the samples that sank in 10 per cent sodium chloride solution showed largest dry-weight and also the highest sucrose content. It is interesting to note that the hexose content of all fruit batches fluctuated but little.

The above-mentioned experiment may, therefore, serve as basis for successfully preparing homogeneous date samples, thus minimizing the sampling error and reducing the number of replicates to be analysed under different experimental conditions.

I. A. A. Nada

Department of Agricultural Botany,
Faculty of Agriculture,
Ain Shams University,
Cairo.
Dec 2.

Imino-Acids in *Santalum* Leaves

Attention has been directed by Giri, Gopalkrishnan, Radhakrishnan and Vaidyanathan[1] to the high content of free hydroxyproline in the leaves of *Santalum album* L , and of free proline in the leaves of various species of *Citrus* Their observations are of interest, as these imino-acids have previously been reported only as minor constituents of the soluble nitrogenous compounds of plant tissues, though they occur regularly as constituents of plant proteins Hydroxyproline in particular has rarely been detected as a component of the soluble nitrogen in plant tissues

Extracts of leaves from two Australian species of *Santalum* have now been examined by paper chromatography. With *S obtusifolium*, the most prominent reactions with ninhydrin and isatin were given by proline, hydroxyproline (confirmed by the specific test of Jepson and Smith[2]) and glutamine, with *S murrayanum* proline gave by far the most prominent spot, but hydroxyproline was also present. There are thus several species in which proline accumulates to comparatively high concentrations which is not entirely surprising in view of its known[3], relationship in various organisms to glutamate, th central metabolic position of which is generall acknowledged

Other 'unusual' amino-acids known to accumulat in individual species include arginine in seedling of various conifers, especially *Abies pectinata*[4,5], an citrulline in roots and root nodules of *Alnus glutinos* and *A incana*[6] The range of plant material examine for amino-acids is still very limited, and the detectio of other 'unusual' amino-acids by simple surve experiments may be anticipated Such plants, a suggested by Giri *et al* [1], may well provide usef sources of compounds not readily accessible t synthesis.

H S. McKee
G. Urbach

Division of Food Preservation and Transport,
Commonwealth Scientific and
Industrial Research Organization,
Homebush,
New South Wales.
Nov. 10

---

[1] Giri, K V , Gopalkrishnan, K S , Radhakrishnan, A N , an Vaidyanathan, C S , *Nature*, 170, 579 (1952)

[2] Jepson, J B , and Smith, I , *Nature*, 172, 1100 (1953)

[3] Fincham, J R S , *Biochem J* , 52, 313 (1953)

[4] Vogel, H J , and Davis, B D , *J Amer Chem Soc* , 74, 109 (1952

[5] Schulze, E , *Z physiol Chem* , 22, 435 (1896–97)

[6] Virtanen A I , and Miettinen, J K , *Nature*, 170, 283 (1952)

Effects of Trace Metals, Oxygen and Light o the Glucose–Glycine Browning Reaction

The reaction of amino-acids and sugars to for brown-coloured products (Maillard reaction) h attracted the attention of many investigators Although such variables as the type of sugar and amino-acid, concentration of reactants, pH, temper ture, and catalytic effects of buffers have bee recognized and controlled in model experiment results of different workers are still difficult reconcile

In recent studies we have found that, under son conditions, the rate of development of colour glucose–glycine solutions is strongly influenced trace amounts of manganese or of iron, by oxyg and by light In a typical experiment illustrati the manganese effect, an aqueous solution contain 0 448 M D-glucose, 0 458 M glycine, 0·0105 disodium hydrogen phosphate, 0·0053 M potassiu dihydrogen phosphate, and 0 4 p p m. mangane (as manganese chloride) was allowed to react in t dark at 50° in sealed glass tubes with air in the hea space. The amount of colour measured at differe time-intervals was 17–24 per cent less than in co trols without manganese (Table 1). In the presen of 2 p p m of manganese there was a 30–40 per ce decrease in the amount of colour formation. (T remarkable sensitivity of the reaction to mangane is illustrated by preliminary experiments carried o

Table 1 INHIBITION OF THE GLUCOSE–GLYCINE BROWNING REACTION BY MANGANESE

Time (hr)	Optical density at 420 mμ* Control	0 4 p p m manganese ions
0	0	0
17	0 020	0 016
39 5	0 193	0 159
46	0 274	0 225
96	1 301	1 077

* Averages of five replicates

under somewhat different conditions and with 'reagent'-grade chemicals Significant inhibition of browning was observed with as little as 0 003 p p m of added manganese. These experiments were repeated independently and confirmed by Miss M Gee of this laboratory.) Manganese was found to inhibit the rate of browning of the solutions in air or oxygen, but under nitrogen no such effect was observed.

In contrast to manganese, iron accelerated the reaction. In a similar system but under oxygen, samples containing 2 p p m of added iron (as ferric chloride) instead of manganese developed four or five times as much colour as controls (Table 2).

Table 2 ACCELERATION OF GLUCOSE–GLYCINE BROWNING REACTION BY IRON

Time (hr)	Optical density at 420 mμ* Control	2 p p m ferric iron
45	0 049	0 271
49	0 065	0 316
66 5	0 151	0 555

* Averages of four replicates

In the course of these experiments, the strong sensitivity of the browning reaction to oxygen and to light was observed In the experiments just described, control samples with no added iron or manganese but sealed under nitrogen developed two to three times as much colour in the dark at 50° as controls sealed under air Light from ordinary laboratory illumination accelerated the reaction in the absence of oxygen On the other hand, partly browned solutions under oxygen or air, when exposed to laboratory illumination at 25°, were gradually bleached, the optical density decreasing 50 per cent in about a week No loss of colour was observed in similar samples sealed under nitrogen

The reagents used for this study were Bureau of Standards D-glucose No 41, Eastman Kodak Co white label' glycine recrystallized twice, spectroscopic standard solutions of manganous chloride and ferric chloride, Bureau of Standards *p*H standard phosphates, and distilled water redistilled in glass. Colour readings were obtained with a 420-mμ filter n an Evelyn photoelectric colorimeter (mention of products does not imply that they are endorsed or ecommended by the Department of Agriculture over others of a similar nature not mentioned)

Further details of these experiments and of others involving various amino-acids, amines, sugars and carbonyl compounds will be given in a forthcoming publication.

G. S. BOHART
JOHN F. CARSON

Western Utilization Research Branch,
Agricultural Research Service,
U.S. Department of Agriculture,
Albany 6, California
Nov 4.

For reviews of the extensive work in this field see, Danehy, J P, and Pigman, W W, "Advances in Food Research", 3, 241 (Academic Press, New York, 1951), and Hodge, J E, *J Agric and Food Chem*, 1, 928 (1953)

Copper – Molybdenum – Sulphate Interaction in Induction of Hypocuprosis

OVINE hypocuprosis has been reported in Australia on pastures containing less than 3–5 p p m. of copper[1] In contrast, British workers have reported a similar syndrome on pastures containing 7–20 p p.m. copper[2]. An explanation of this apparent anomaly has been proposed by Dick, based on his findings on the effects of molybdenum[3] and, more recently, sulphate[4–6], on copper metabolism.

We have now diagnosed ovine hypocuprosis, characterized by white banding of black wool, enzootic ataxia, and, though not marked, dystrophic ('steely') wool, on pastures in New South Wales containing 3–10 p p m copper, 3–9 p.p.m. molybdenum and 0 1–0 7 per cent sulphate. In order to ascertain if these levels of the three factors could have been responsible for inducing the hypocuprosis, a pen experiment has been carried out with a diet approximately reproducing the mean copper – molybdenum – sulphate status of the feed in the affected area, with suitable controls. The basal diet consisted of wheaten chaff 40, wheat 24, oats 30, meatmeal 5, urea ¾, limestone ½, salt ½, plus vitamin A and cobalt supplements. Merino weaners were used, with some black sheep included in all groups. All diets were fed *ad lib.* except in the case of group 3, which was fed at approximately half the intake of group 2 Details of treatments and results are shown in Table 1.

Table 1. EFFECT OF COPPER, MOLYBDENUM AND SULPHATE ON LIVER-COPPER OF SHEEP.

Group No	Composition of diet			No of sheep	Pre-exp * mean liver-copper (p p m dry wt)	Mean* liver-copper after 4 months (p p m dry wt)
	Copper (p p m)	Molybdenum (p p m)	Sulphate (per cent)			
1	6	0 7	0 04	6	254	169
2	6	5	0 4	7	222	45†
3	as 2, but at half-rations			6	203	39†
4	6	5	0 04	7	306	181
5	6	0 7	0 4	6	230	93†

* Samples for analysis were obtained at biopsy (ref 7)
† Falls in liver-copper of groups 2, 3 and 5 significantly ($P < 0\ 01$) greater than group 1, and of groups 2 and 3 significantly greater than group 4 ($P < 0\ 01$)

The rapid fall in liver-copper in the high molybdenum high-sulphate groups is apparent The mean liver-copper of groups 2 and 3 had dropped to 12 9 and 8·9 p p.m. respectively after eleven months. At the same time, the mean blood-coppers of groups 2 and 3 were 0 041 and 0·035 mgm. per 100 ml, as compared with mean values for normal sheep of *c.* 0 08 mgm. per 100 ml Dystrophic wool and white banding of black wool, similar to that observed in the field, were observed in the deficient sheep The results with group 3, on half the feed-intake of group 2, suggest that it is not so much the absolute intake of copper, molybdenum and sulphate which is important, but rather the concentration in the diet.

A feature of the experiment has been the demonstration of the profound influence of sulphate. The results from group 5 show that even when the molybdenum concentration of the feed was 0 7 p.p m., added sulphate caused a significant fall in liver-copper as compared with the controls. Later analyses have indicated that there is a large individual variability in the response to sulphate additions to low molybdenum diets, some sheep declining to less than

20 p p m. of copper in the liver on such a diet. Dick also has found that sulphate added to a diet providing 0 5 mgm. of molybdenum per day depressed the accumulation of copper by the liver[5].

It is apparent from these observations that, in conformity with Dick's hypothesis, the disparity between the copper-levels found in pastures associated with hypocuprosis can, at least in some cases, be explained by copper – molybdenum – sulphate interaction inducing low liver and blood copper-levels Dick has, of course, recently shown that very high levels of molybdenum and high levels of sulphate may result in dystrophic wool without a low level of blood- or liver-copper[8], but the present work appears to be the first demonstration of the induction of hypocuprosis associated with hypocupræmia and low liver-copper by adjusting the copper, molybdenum and sulphate to levels encountered in the field.

Bovine hypocuprosis in New South Wales has been associated with pastures containing 8–12 p p.m copper, 1–5 p.p m molybdenum, and 0 6–0 9 per cent sulphate. It seems probable that copper – molybdenum – sulphate interaction is also involved in these hypocuproses.

K. N. WYNNE
G. L. MCCLYMONT
Nutrition Research Laboratory,
Veterinary Research Station,
Glenfield, New South Wales.
Oct. 29.

[1] Beck, A B , *J Dept Agric W Aust* , 18, 285 (1941)

[2] Allcroft, R , *Vet Rec* , 64, 17 (1952)

[3] Dick, A T , and Bull, L B , *Aust Vet J* , 21, 70 (1945).

[4] Dick, A T , *Nature*, 172, 637 (1953)

[5] Dick, A T , *Aust Vet J* , 29, 233 (1953)

[6] Dick, A T , *Aust J Agric Res* , 5, 511 (1954).

[7] Dick, A T , *Aust Vet J* , 28, 234 (1952)

[8] Dick, A T , *Aust Vet J* , 30, 197 (1954)

Ultra-violet Absorption Investigation of Melanins

ULTRA-VIOLET absorption studies demonstrate that the melanin of the ox-choroid is similar to the melanin obtained by the autoxidation of β-3 4 dihydroxyphenylalanine[1]. In the present communication, it will be shown that the melanin of the ox-choroid is identical with that of black human hair, while red human hair contains a pigment related to, but not identical with, these melanins

. Melanin was prepared from the ox-choroid as described previously[1]. Curve *A* (Fig. 1) depicts the ultra-violet absorption spectrum of choroid-melanin in *M* sodium hydroxide.

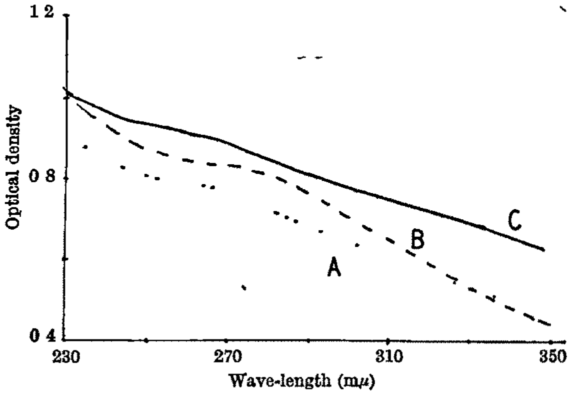


Fig 1

Samples of black and red human hair were defatted and boiled with 5 *M* sodium hydroxide for 12 hr. Most of the hair pigment dissolved, undissolved hair being removed by centrifugation. On acidification of the alkaline solutions, black pigments were precipitated and were sedimented by centrifugation. The supernatant acidified solution from the red hair was red in colour, that from black hair a pale yellow. The acid-precipitated pigments were soluble in alkali and could be purified by repeated solution in alkali and precipitation by acid. Curve *C* depicts the ultra-violet absorption spectrum of the purified black hair melanin, curve *B* that of the 'melanin' from red hair, both pigments being in solution in *M* sodium hydroxide.

It will be observed that the melanin from black human hair is identical with that from the ox-choroid, both pigments differing somewhat from the red hair 'melanin'.

On combining alkaline solutions of the acid-soluble and the acid-insoluble red hair pigments, a colour was obtained which matched the colour of the hair in its natural state. Thus, it does not seem likely that either pigment arose as an artefact during the preparation.

It is characteristic of the natural and synthetic melanins that they dissolve in alkalis, but are insoluble in acids By this criterion and by virtue of its colour, the acid-insoluble pigment from human red hair can be considered to be related to the 'true' melanins. It appears, therefore, that red human hair contains a melanin-like pigment in addition to the red pigment described by previous investigators[2].

The observations above indicate that ultra-violet absorption analyses may be useful in differentiating between various melanin pigments. It would be worthwhile, therefore, to extend such studies to include other vertebrate and invertebrate melanins.

I wish to thank Prof Joseph Gillman for advice and encouragement during this investigation.

W D STEIN
Department of Physiology, and
Joint Nutrition Research Unit of the
Council for Scientific and Industrial Research,
and the
University of the Witwatersrand Medical School,
Johannesburg.
Nov 15

[1] Stein, W D , *Nature*, 174, 601 (1954)

[2] Rothman, S , and Flesch, P , *Proc Soc Exp Biol and Med* , 62, 20 (1943)

Metabolism of Thyroglobulin labelled with Iodine-131

DIFFERENCES in the fate of thyroglobulin labelle with iodine-131 appearing in the plasma of patient treated with therapeutic doses of radioactive iodide have led us to study the metabolism of thyroid prote in animals. In rats, doses of radioactive iodid sufficient to destroy the thyroid gland result in th appearance of labelled thyroglobulin in the plasm The protein is speedily removed, radioactive thyroxin and iodide appearing in the plasma Administratio of rat thyroglobulin to normal rats or to rats which the gland has been previously eliminated b radioactive iodide gives the same pattern of event (Table 1)

Table 1 DISTRIBUTION OF RADIOACTIVE COMPONENTS OF RAT PLASMA FOLLOWING INTRAVENOUS INJECTION OF LABELLED RAT THYROGLOBULIN

Hours after dose	Percentage dose in plasma	Distribution of plasma activity (%)		
		Iodide	Thyroxine	Protein
2	25 8	7	3	90
6	17 8	8	0	92
23	6 3	12	6	82
47	1 1	21	14	65
73	0 5	31	13	56

Similar results were obtained when dog thyroglobulin was administered to dogs.

Dog thyroglobulin injected into rats is removed and metabolized much more slowly, similar results were obtained when rat thyroglobulin was injected into dogs Successive injections of the heterologous thyroglobulin induced an immune reaction whereby the injected thyroid protein was then removed extremely rapidly (Fig. 1). On the other hand, repeated administration of homologous thyroid protein, for example rat protein to rat, over a wide dose-range, failed to modify the rate of removal of the protein

This striking difference in behaviour between homologous and heterologous thyroglobulin in these two species indicates that a mechanism normally exists for the rapid and selective removal from plasma of homologous but not heterologous thyroid protein. It is tempting, on this evidence, to speculate that the thyroid gland may normally secrete thyroglobulin which is then rapidly metabolized, liberating iodide and thyroxine. Failure to detect thyroglobulin in plasma[2] could be due to its speedy removal keeping circulating thyroglobulin at levels below the limits of detection by available methods.

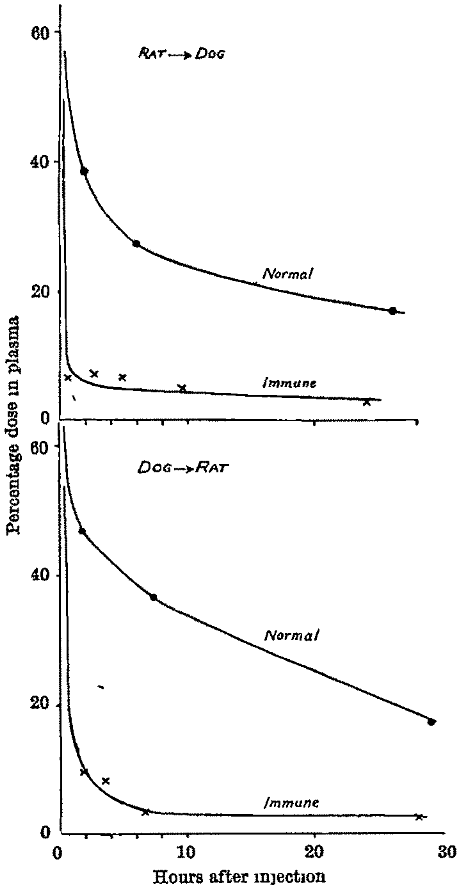


Fig 1 Removal of radioactive thyroglobulin from the plasma of normal and immune animals Upper graph, rat thyroglobulin to dog, lower graph, dog thyroglobulin to rat In the immune animals more than 90 per cent of the residual radioactive material after a few hours consists of iodide, thyroxine and iodotyrosines

However, the first administration of rat thyroglobulin to monkeys resulted in its rapid removal from plasma, with the appearance of iodide and thyroxine.

Clearly, variations exist between species in their ability to metabolize homologous and heterologous thyroglobulin. This investigation is being extended to other species, and full details will be published elsewhere.

FRED BROWN
HAROLD JACKSON
Dept of Experimental Radiation Therapeutics,
Christie Hospital and Holt Radium Institute,
Manchester 20.
Nov 18

---

[1] Brown, F, and Jackson, H., *Biochem J*, 56, 399 (1954)

[2] Lerman, J, *J Clin Invest*, 19, 555 (1940).

Relation of Colour Change to Moulting in Prawns

STUDIES of crustacean hormones have heretofore been concentrated either on chromatophorotropic actions, or upon effects on moulting and related metabolic phenomena. We have now obtained evidence that, in *Leander serratus* (Pennant), the chromatophorotropic hormones are also concerned in the intermoult cycle Numerous previous studies have shown that eyestalk removal accelerates moulting in many species of crustaceans, including *L. serratus*[1]. We found that, in a series of 114 eyestalkless animals, only two moulted, while of 146 normal animals kept under identical conditions, twelve moulted This difference is statistically significant at the 5 per cent level of probability We are unable to account for the difference from Drach's results[1], but Carlisle (personal communication) has suggested that there are important racial differences between prawns of the same species at Naples, Roscoff and Plymouth Analysis of the effect of removal of eyestalk showed that it could be attributed to an increase in length of stage D_2 of the intermoult cycle[2], during which the old integument is undergoing resorption, and the new integument is being formed, and to an increased mortality immediately preceding the moult in eyestalkless specimens.

Examination of the chromatophores of the animals used in the eyestalk-removal studies showed that these undergo a small but significant cyclic change in state of dispersal of pigment during the intermoult cycle. Moreover, the state of dispersal in each of four major groups of chromatophores can be correlated with the duration of one or more of the stages of the intermoult cycle. For example, the large red chromatophores of the body stripes are significantly more concentrated in animals which pass rapidly through stage D_2 than in those which die before completing the transition to the next stage, marked by softening of the old integument. Likewise, the duration of stage D_3, immediately preceding the moult, is correlated with the state of dispersal of the blue pigment of the stripes. In eyestalkless animals, all the pigments studied are more widely dispersed than in normals, most of the cyclic changes are abolished, and there is no correlation between the length of any stage and the dispersal of the pigments This suggests that the major control of the intermoult cycle resides in the eyestalks

Extracts of eyestalks and central nervous systems of the prawns in sea water were tested for chromatophorotropic effects, already demonstrated in this species by Knowles[3] Concentrating factors were found for all four pigment groups observed, in both types of extracts. Dispersing factors for two groups were present in the central nervous system, and for one group in the eyestalks Only a fraction of the extracts exhibited any one of these effects. The frequency of appearance of any effect was not correlated with the colour of the donor, but in some cases there was a marked variation of frequency with stage of the donor in the intermoult cycle

A detailed analysis of the results leads us to the conclusion that at least five chromatophorotropic hormones are concerned in events which determine the duration of specific stages in the intermoult cycle, and that none of these hormones is identical with the moult-inhibiting hormone described for several other crustaceans. Our results provide no evidence of the operation of this latter hormone in *Leander serratus*; but neither do they show that it is not involved. A more detailed account of the methods and results will appear in *Pubbl Staz. Zool.*

This work was done during tenure of a Fulbright fellowship in Italy We are indebted to the director and staff of the Stazione Zoologica for hospitality and many kindnesses

BRADLEY T SCHEER
MARLIN ANN RAY SCHEER

Stazione Zoologica di Napoli,
and
University of Oregon,
Eugene, Oregon.
Oct 12.

---

[1] Drach, P, *Bull Biol*, 78, 40 (1944), *C R Acad Sci*, *Paris*, 225, 1376 (1947)

[2] Drach, P, *Ann Inst Oceanogr*, 19, 103 (1939)

[3] Knowles, F G W, Proc XIV Int Zool Congr, Copenhagen (1953)

Aphid Take-off in Controlled Wind Speeds

DAVIES has demonstrated[1] in a wind tunnel that *Myzus persicae* Sulz did not take to flight in wind speeds greater than 3 75 m p h His experiments, and field observations by other research workers, have given rise to a generalization that aphids do not take off in wind velocities greater than 5 m p h [2]

Recent work at Rothamsted has shown that alate aphids (for example, *Aphis fabae* Scop. and *Brevicoryne brassicae* L.), when in the highly active state through which they pass on reaching flight maturity, proved able to take off in wind speeds up to 6–7 m p h [3] Wind velocities of 3 m.p h continuously maintained caused a delay of 4–10 hr for first take-off, wind speeds of 5 m.p h a delay of approximately 24 hr or even more After these extensions of the normal preflight period, summer migrants of *A. fabae* and *Br. brassicae* took off with great regularity.

Further experiments were carried out to examine whether the ability to take off in relatively high wind speeds is a general feature of aphids or whether it is restricted to certain species. The tests were made with twenty species of host-alternating and non-host-alternating aphids and adelgids and the seasonal forms. In the following summary, wi speed is considered apart from other environment factors, for its influence appeared to be over-ridin

The newly moulted alatæ were transferred small leaves of their breeding host plant which we kept in fresh condition. Exposed to the wind, t aphids usually took off from the exposed side of t leaf into or diagonally against the wind directio The actual take-off, with very few exceptions, was voluntary process often undertaken after many tria Once in the air, the aphids immediately lost contr over their flight direction and were blown away ev by wind speeds as low as 1 2–1 5 m p h

As a rule, tree aphids tested in the wind tunn took off less readily and in smaller proportions wind-velocities of 5 and even 3 m p h. than *A fab* and *Br. brassicae*, but they kept their ability to f in calm air over long periods The experimen included the following non-host-alternating specie *Cinaropsis pilicornis* Hartig, *Periphyllus aceris acer* *cola* Wlk , *Euceraphis punctipennis* Zett., *Phyllaph* *fagi* L , *Drepanosiphon platanoides* Schr , *Eucallipter* *tiliae* L and *Tuberculoides annulatus* Hartig. It w noticed that the beech aphid *Ph. fagi* flew well calm air on its twelfth day, the birch aphid *punctipennis* on its thirtieth day after collection an *Drepanosiphon platanoides* on the seventieth da after the last ecdysis Early autolysis of flig muscles, as recently demonstrated for *A. fabae,* *persicae* and others by B Johnson[4], does not occ in these species, as will later be shown in more deta

In wind velocities of 5 m p h the adelgids, to were characterized by a noticeably hesitating b haviour, but take-offs in 3 m p h could be observe for *Adelges strobilobius* as well as *Adelges abietis* Hard

More willingness to take off in relatively high win was generally demonstrated by the host-alternati aphids, among which the spring migrants on the primary host were characterized by a remarkab energy. The following species proved able to take o with great regularity in wind speeds of 5 m p h. aft only a few hours delay, and often within the fir 24 hr. after their last ecdysis *Rhopalosipho* *insertum* Wlk., *Aphis evonymi* F., *Brachycaud* *helichrysi* Kltb., *Longicaudus trirhodus* Wlk an *Hyperomyzus lactucae* C B.

As a rule, summer migrants (for example, *A. fab* and *Br. brassicae*) appeared to lack this energy an preferred the lower speeds to the higher, but we able to take off in different speeds of 3–6 m.p. after a sufficiently long delay of their departure, shown before.

No take-off, however, was observed for *Macr* *siphon euphorbiae* Thos. = *M solanifolii* Ashm wind velocities of 5 m.p.h , but in some cases f *Megoura viciae* Bckt.

Autumn migrants of *A. fabae* and *Br. brassic* took off readily in the highest wind speeds teste (7 2 and 6 9 m.p.h. respectively) *A. fabae* alatæ al proved able to start in speeds of 5–6 m.p h eve after three to four days of previous flight exercis when kept on their secondary host plant[3]. This ma indicate a special take-off behaviour which, so f as autumn migrants are concerned, does not appe to be limited to first departures

The differences in the behaviour between the speci as well as between their seasonal forms, briefly out lined above, will have to be interpreted in the lig of their migratory flight as well as their host-pla relationship.

This work will be published later with special reference to its ecological aspect. I am grateful to Dr. C. G. Johnson for criticism, and to Dr. J. P. Doncaster and Dr. H. L. G. Stroyan for help in identifying a number of species.

ELSE HAINE

Department of Entomology,
Rothamsted Experimental Station,
Harpenden, Herts.
Nov. 11.

[1] Davies, W. M., *Ann. App. Biol.*, 23, 401 (1936).

[2] Johnson, C. G., *Biol. Rev.*, 29, 87 (1954).

[3] Haine, E., *Anz. f. Schädlingsk.*, 27, 55 (1954).

[4] Johnson, B., *Nature*, 172, 813 (1953).

Formation of the Infection Bulb in *Arthrobotrys oligospora* Fresenius

IN network- and knob-forming Hyphomycetes which are predacious on nematodes, it has long been considered that the structure known as the infection bulb is in some way instrumental in bringing about the death of the prey.

This structure, a kind of internal appressorium, can be observed in the early stages of infection, that is, soon after the capture of the eelworm, as a bulbous extension of the hypha of the attacking fungus within the body of the nematode, just at the point of invasion. It is from this bulb that the trophic hyphæ grow out and extend throughout the body of the worm.

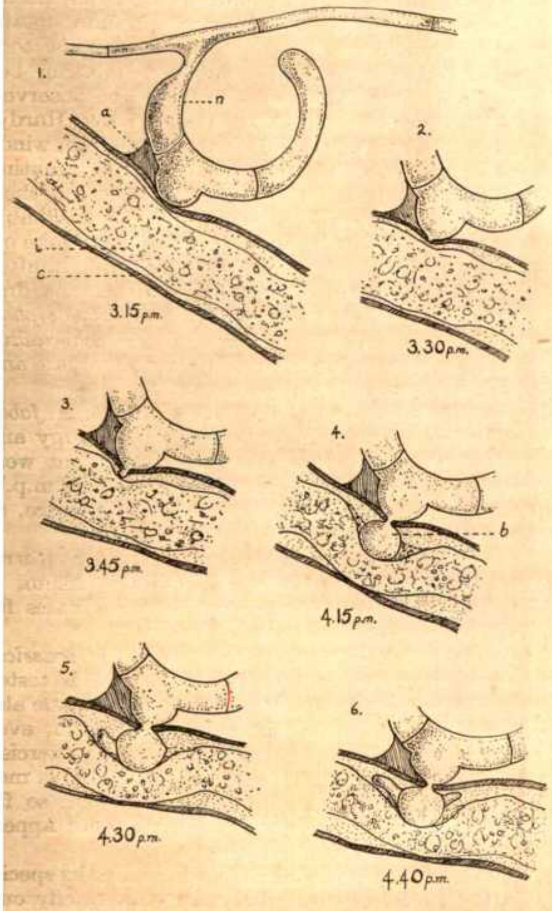


Fig. 1. *Arthrobotrys oligospora*. Observed stages in the development of the infection bulb. *a*, Adhesive substance; *b*, infection bulb; *c*, cuticle of nematode; *i*, intestine; *n*, primary branch of network

Drechsler[1] refers to the bulb as a 'mortiferous' structure and considers that it is a mechanical action by which the nematode is killed, the bulb filling the diameter of the body to such an extent that death is brought about because of the virtual severance of the body which results. Duddington[2] regards this view with some uncertainty.

From observations made on the formation of the infection bulb in *Arthrobotrys oligospora* Fres., the whole development of the bulb was traced from the early stages of capture, when the nematode was moving vigorously, to the final stage when the nematode had ceased to move, being either dead or paralysed. The fungus was observed while growing on maize-meal agar in a Petri dish. A cover-glass was placed over a drop of water on the surface of the agar and an oil immersion objective used with × 7 oculars. The resulting light intensity was not sufficient to permit the use of the camera lucida, the accompanying figures being free-hand drawings of the observed stages (Fig. 1).

The noticeable features of these observations were first, the rapidity with which the haustorium and infection bulb were formed when once invasion had started, the bulb reaching its maximum size within 45 min. of the inception ; secondly, the rate at which movements of the nematode were reduced very soon after the invasion occurred, becoming considerably inhibited as soon as the haustorium had penetrated the cuticle (stage 3, Fig. 1), and ceasing completely shortly afterwards (stage 5). It is also of interest that, in this particular instance, the infection bulb never reached a size greater than about half the diameter of the worm. It is questionable whether the partial obstruction of the body cavity thus produced could, in itself, bring about such a rapid death of the host.

This work was carried out under a scholarship from the British Council, to which my thanks are due. I am also indebted to the Director and staff of the Danish State Experimental and Research Station for Plant Diseases and Pests, Lyngby, for providing the necessary facilities.

AUDREY M. SHEPHERD

School of Agriculture,
University of Cambridge.
Nov. 19.

[1] Drechsler, C., *Mycologia*, 29, 452 (1937).

[2] Duddington, C. L., *J. Quekett Micr. Club*, (4) 3 75 (1950).

Electron Diffraction Pattern of Mica of Various Thicknesses

N-PATTERNS of spots from thin crystals, and Kikuchi-lines from comparatively thick ones, have been observed by several workers[1] as electron diffraction patterns from mica. In this study a flake of mica having various thicknesses was stuck on a mesh of 0·1 mm. diameter by means of methyl alcohol and was then placed on the projection lens of an electron microscope so that electron micrographs and electron-diffraction patterns of the mica might be taken. First the electron image of the mica (Fig. 1*a*) was observed, then the incident electron beam was converged on it (the least area illuminated

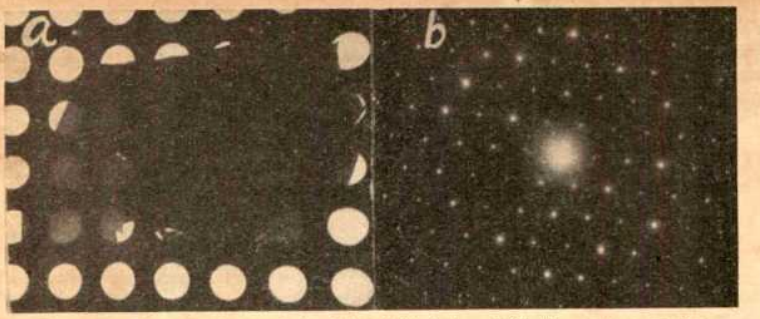


Fig. 1. (*a*) Electronmicrograph (× 47) and (*b*) electron diffraction pattern of mica

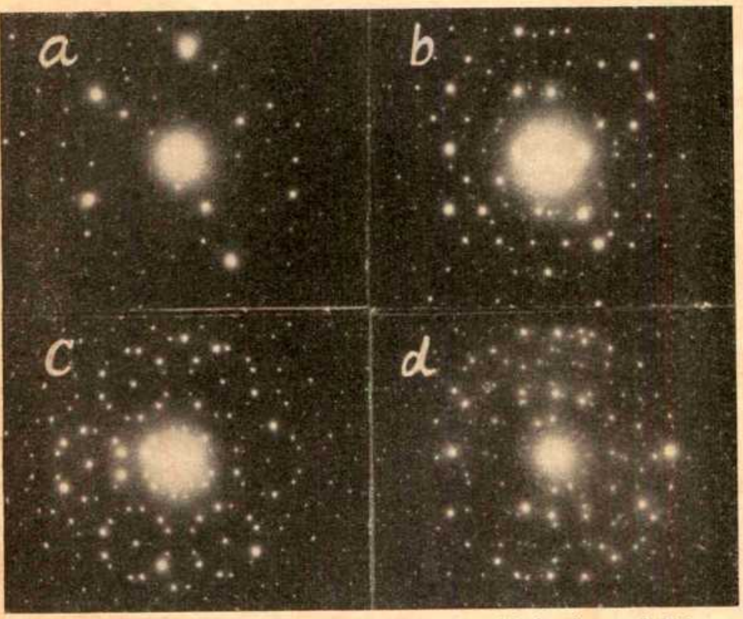


Fig. 2. Various electron diffraction patterns appearing with the change of thickness of mica

by the electrons was a circle of about 0·01 mm. diameter), and was moved horizontally to the part of the mica to be observed having the desired thickness. Then the electric current through the projection lens was switched off, and afterwards the electron diffraction pattern of one part of the mica (Fig. 1 *b*) was observed. The thickness of each part of the mica was determined relatively by comparing the intensities of the transmitted electrons.

In the case of a very thin crystal (about 400 ∼ 500 A.) an *N*-pattern with many missing diffracted points appeared (Fig. 2 *a*). With increased thickness of the mica the electron diffraction pattern changes successively as follows: (1) a perfect *N*-pattern was first obtained (Fig. 1 *b*), (2) a pattern such as that shown in Fig. 2 *b* appeared next, (3) a pattern such as that shown in Fig. 2 *c* was then obtained, and later, (4) a pattern such as Fig. 2 *d* appeared. With still further increase in thickness of mica, a pattern as shown in Fig. 2 *a* appeared again, after passing through the patterns of Figs. 2 *c*, *b* and then Fig. 1 *b* successively. In the case of mica having such thickness as this, Kikuchi-lines begin to appear; but where the crystal was so thick that many Kikuchi-lines would be expected to appear, it showed an *N*-pattern of spots as already observed. If there exists such interesting periodic changes in electron diffraction patterns with the increase in thickness of mica, the pattern such as Fig. 2 *b* or *c* should be obtained in the case of a thicker mica than that in which the pattern of Fig. 2 *d* appears. As a matter of fact, such patterns were obtained in the case of mica so thick that the central spot shows pronounced halation.

In the cases of bent crystals, all patterns were blurred through charging-up. By means of the condenser lens, two neighbouring parts of mica having different thicknesses were observed independently, and then an electron diffraction pattern was taken by using full illumination of electrons to cover the two parts of the mica. In this case the pattern obtained was the same as the superposition of the two independent patterns. Accordingly, the above-mentioned patterns were not due to an imperfect crystal, but rather the original structure of the mica. The electron diffraction patterns obtained in this study were therefore analysed as follows.

The pattern of Fig. 2 *b* may be considered as due to two crystal layers which consist of a fundamental crystal and a crystal rotated by about 10°. The pattern of Fig. 2 *c* would be due to a three-layer crystal group which consists of the fundamental crystal and crystals rotated at about 10° and 20°. The pattern of Fig. 2 *d* can also be explained as a four-layer crystal group consisting of the fundamental crystal and crystals rotated at the angle of about 10°, 20° and 30°. Furthermore, diffracted points from the fundamental crystal and a second or a third crystal superposed on each other are very bright, and the diffracted points of incident and exit crystals are brighter than those of intermediate ones. If we assume from these observations that mica grows as strata which rotate at the angle of about 10° successively, the periodicity of electron diffraction pattern with thickness of mica can be explained; patterns such as those shown in Figs. 2 *b*, *c* and *d* indicate the existence of rotational slip, as already discussed by H. Wilman[2].

However, from the results of this experiment in which the degree of electron transmission was adopted as the parameter of thickness, it is still premature to give a conclusive judgment whether such a crystal growth is the natural habit of mica or not. More precise observations are therefore in process. I wish to thank Mr. S. Takahashi for his assistance.

TADATOSI HIBI

Research Institute for Scientific Measurements,
Tôhoku University,
Sendai, Japan.

---

[1] For example, Kikuchi, S., *Proc. Imp. Acad. Jap.*, **4**, 271, 354 (1928). Bragg, W. L., *Nature*, **124**, 125 (1929).

[2] Wilman, H., *Nature*, **165**, 321 (1950); *Proc. Phys. Soc.*, **A**, **64**, 329 (1951).

Reversible Polarographic Reduction of Niobium

THE polarographic reduction of niobium in concentrated hydrochloric acid[1], and in oxalate and tartrate solutions (ref. 2 and Mrs. B Lamb, private communication), has been shown to be due to reduction of Nb(V) to Nb(IV) Reductions in these media are, however, irreversible Recent studies on the precipitation of niobium with tannic acid from various complexing solutions (G. W C. Milner, G A. Barnett and A. A Smales, unpublished work) in this laboratory have indicated that niobium forms complexes with malic, citric, lactic and ethylenediamine-tetra-acetic acids We have found polarographic steps corresponding to the reduction of these complexes.

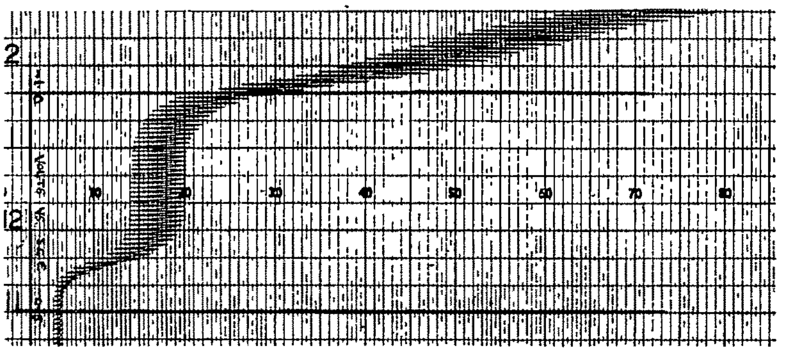


Fig 1

The reduction of niobium from solutions of the disodium salt of ethylenediamine-tetra-acetic acid produces polarographic steps (see Fig 1), at *p*H 3 05, $E_{1/2}(1) = -0\ 609$ V., $E_{1/2}(2) = -1\ 05$ V vs. the saturated calomel electrode. The second step coalesces with the hydrogen wave and is difficult to measure with conventional polarographic equipment The half-wave potential and reversibility (tested by measurement of the inverse slope of E against $\log_{10} i/(i_d - i)$ plot) of the first wave varies with *p*H.

*p*H	[EDTA]	$E_{1/2}$ (1)	Slope
2 00	0 001 *M*	−0 419	0 060
3 05	0 1 *M*	−0 609	0 059
3 20	0 1 *M*	−0 613	0 062
3 40	0 1 *M*	−0 615	0 069
3 60	0 1 *M*	−0 657	0 072
4 05	0 1 *M*	−0 767	0 100
4 75	0 1 *M*	−0 835	0 086

(A slope of 0 059 corresponds to a reversible one-electron reduction)

Studies in solutions at *p*H 3 20 show that the height of the first wave is proportional to the niobium concentration over the range 500–5 μgm /ml The occurrence of two peaks when the Barker square-wave polarograph is used confirms the reversibility of the electrode reactions[3], for the height of the peaks obtained is similar to that obtained from a thallium solution of the same molarity The first of these peaks can be used as a measure of concentration and extends the limit at which niobium can be measured to 0 1 μgm /ml.

A fuller account of this work will be published elsewhere

D. J FERRETT
G W. C MILNER

Analytical Chemistry Group,
Atomic Energy Research Establishment,
Harwell, Berks Nov 18.

Cozzi, D , and Vivarelli, S , *Ricerca sci* , 23, 2244 (1953)
Elson, R E , *J Amer Chem Soc* 75, 4193 (1953)
Ferrett, D J , and Milner, G W C , *Analyst*, [80, 132 (1955)]

Inefficiency of Diphenylpicrylhydrazyl as a Radical Scavenger

IN the quantitative study of a reaction proceeding by a radical mechanism, it is of prime importance to know accurately the rate of generation of radicals in the system For this purpose, α,α-diphenyl-β-picrylhydrazyl has been used as a radical scavenger This material is a free radical and has the structure $(C_6H_5)_2N.N.C_6H_2(NO_2)_3$ It is stable itself but interacts with reactive radicals to give stable products, it has a strong purple colour and the rate of fading of this colour in solution has been used for measuring the rate of production of radicals in the solution[1]. Provided that the concentration of α,α-diphenyl-β-picrylhydrazyl is not very small, the calculated rate of production of radicals is independent of its concentration. This result suggests that the scavenger captures all the radicals which are produced

Azo-*iso*-butyronitrile is commonly used as a source of free radicals, its decomposition can be represented as

$$(CH_3)_2C(CN).N\ N.C(CN)(CH_3)_2 \rightarrow 2(CH_3)_2C(CN) + N_2$$

The decomposition can be followed either by measurement of the nitrogen evolved or by the use of α,α-diphenyl-β-picrylhydrazyl[1] The rate measured by the latter method is a little less than the rate measured from nitrogen evolution[2]. It appears that some of the radicals generated from the azo compound do not react with α,α-diphenyl-β-picrylhydrazyl but instead interact with one another to give stable products. Some of the papers presented at a recent meeting of the American Chemical Society dealt with this subject[3].

It has now been proved by a direct method that α,α-diphenyl-β-picrylhydrazyl does not react with all the radicals produced during the decomposition of azo-*iso*-butyronitrile in benzene solution If ^{14}C-azo-*iso*-butyronitrile is used, it is possible to determine with accuracy the products resulting from radicals escaping the scavenger A typical experiment can be summarized as follows. a mixture of 2 7 mgm ^{14}C-azo-*iso*-butyronitrile and 39 2 mgm. α,α-diphenyl-β-picrylhydrazyl in 1 35 ml. benzene was kept at 60° for 16 hr in the complete absence of air, it was found afterwards that the solution contained 0 15 mgm of tetramethylsuccinodinitrile formed by the combination of pairs of $(CH_3)_2C(CN)$ radicals If the velocity constant for the first-order decomposition of azo-*iso*-butyronitrile at 60° is $1\ 20 \times 10^{-5}$ sec $^{-1}$, the calculated weight decomposed is 1 35 mgm Work on the decomposition of this substance in benzene and other inert solvents[4] shows that other products are also formed from the radicals, and that for a decomposition performed under the conditions of this experiment 0 15 mgm. tetramethylsuccinodinitrile is equivalent to 0 40 mgm azo-*iso*-butyronitrile. It appears, therefore, that the radicals from only 0 95 mgm of the decomposed azo compound react with the nitrile, and that the scavenger reacts with only about 70 per cent of the radicals generated in the system.

It is also found that, when the azo compound is decomposed in the presence of styrene, some of the radicals are not used in initiating polymerization chains (unpublished results) The efficiency of initiation is independent of the concentration of monomer if its concentration is not small The failure of the scavenger and the monomer to capture all the radicals can be ascribed to a cage effect The radicals are generated in pairs and therefore their direct interaction is favoured.

The actual mechanism of the reaction between α,α-diphenyl-β-picrylhydrazyl and radicals is not certain[5], but it is hoped to obtain evidence using the carbon-14 compound This material has been synthesized and will be used for seeking the various possible products

Details of these and other experiments designed to study the action of radical scavengers will be published later I thank Prof H. W. Melville for his interest in this work

J C BEVINGTON

Chemistry Department,
University,
Birmingham 15
Nov 12.

---

[1] Bawn, C E H, and Mellish, S F, *Trans Farad Soc*, **47**, 1216 (1951)
[2] Walling, C, *J Polymer Sci*, 14, 214 (1954)
[3] Meeting at New York in September 1954 of the Division of Polymer Chemistry of the American Chemical Society
[4] Bevington, J C, *J Chem Soc*, 3707 (1954)
[5] Wild, W, Disc Farad Soc, 12, 127 (1952)

Use of Triethylammonium Buffers in Ion-Exchange Chromatography and Electrophoresis

IN preparative ion-exchange chromatography or electrophoresis of mixtures of low-molecular non-volatile compounds, it is essential to use buffer salts that are easily removed Many methods have been employed or proposed for desalting. Of these, only evaporation of the buffer can, in our opinion, be considered as entirely satisfactory, since it introduces no other operation than the one required for the removal of the solvent The number of volatile buffers in use so far is much limited, and those buffers do not meet all demands

For some time, buffers made from triethylamine have been used in ion-exchange chromatography and electrophoresis at this Institute Trimethylammonium salts may serve the same purpose, but we have found the triethylammonium salts preferable since triethylamine, due to its higher boiling point, is more convenient to handle and is easier to purify than is trimethylamine Triethylammonium formate, acetate, bicarbonate and carbonate are all volatile and cover the approximate *p*H ranges 3–6 and 7–12 In many respects these buffers are superior to all volatile buffers used so far (pyridinium[1], collidinium[2] and ammonium[3] acetates and formates) They have the following advantages (1) They can be removed by lyophilization (2) Ultra-violet absorption can be measured without prior removal of the buffer (3) A number of reactions proceed without complications in the presence of these buffers Particularly noteworthy is the fact that little or no interference takes place in the ninhydrin reaction according to Moore and Stein[4] when aliquots of 0 1–0 5 ml of column fractions are taken if the concentration of the amine is 0 1 *N* or less Much larger amounts of the amine may cause too high blank values (possibly due to traces of impurities) Disturbing background colour also results on paper containing triethylammonium buffer when the paper is strongly heated (4) They are stable towards oxidation (collidinium salts are anodically oxidized).

It is obvious that much time and labour may be saved when these buffers can be used for fractionation of mixtures containing both ninhydrin-positive and ultra-violet absorbing material Excellent fractionations of mixtures of amino-acids, in free and bound form, and purine and pyrimidine compounds have been obtained on 'Dowex 50' by the use of triethylammonium formate and acetate

JERKER PORATH

Institute of Biochemistry,
University of Uppsala
Nov 11.

---

[1] Michl, H, *Mh Chem*, 82, 489 (1951)
[2] Newton, G G F, and Abraham, E P, *Biochem J.*, 58 103 (1954)
[3] Hirs, C W H, Moore, S, and Stein, W H, *J Biol Chem*, 195, 669 (1952)
[4] Moore, S, and Stein W H, *J Biol. Chem* 176, 367 (1948)

Preparation of Hexachlorocyclohexane with 18–20 per cent Gamma-Isomer Content

IN Greece, hexachloro*cyclo*hexane was first synthesized during 1948, by the chlorination of benzene in white demijohns in the presence of sunlight. This method was convenient due to the clear sky of the country.

The hexachloro*cyclo*hexane so prepared was examined by La Clair's method, namely, rate of dehydrochlorination at 0° C, and it was found that it contained 8–10 per cent γ-isomer

It is well known that the insecticidal activity of hexachloro*cyclo*hexane depends upon its content of γ-isomer, and for this reason we investigated the possibility of increasing the γ-isomer content of our product Chlorinations under different conditions were carried out, and it was found that when the chlorination took place in yellow or red demijohns, instead of white ones, the product contained 18–20 per cent γ-isomer This increase in γ-isomer content is attributed to selective chlorination favouring the formation of the γ-isomer

The chlorination of benzene in monochromatic light must be further investigated in order to find out the real reason for the formation of hexachloro*cyclo*hexane with higher γ-isomer content Aiming at the commercial production of hexachloro*cyclo*hexane on a higher scale, we carried out the chlorination of benzene inside closed Pfaudler vessels, using fluorescent lamps and different temperatures From this work it was found that if the chlorination of benzene was carried out at a temperature of 35–45° C and mercury radiation 2537 A with a fluorescent substance (the lamp contains argon under 8 mm mercury pressure), zinc orthosilicate (for green light) and calcium tungstate (for blue light), then the product formed contains 18–20 per cent γ-isomer

MILTIADES N. VARNAVAS

Department of Organic Chemistry,
N. Canellopoulos Institute,
Piraeus
Oct 5.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 14

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W C 1), at 4 30 p m Annual General Meeting 5 30 p m —Mr B A Farrell 'Scientific Method and Understanding of Persons"

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Prof T M Cherry (Melbourne) "Fact and Fiction in Elementary Dynamics" *

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5 45 p m —Prof H N Rydon "The Structure of the Proteins"

Royal Society of Arts (at John Adam Street, Adelphi London, W C 2), at 6 p m —Prof Hugh Ford "Tensile Properties" (First of three Cantor Lectures on "The Mechanical Properties of Metals")

Institution of Electrical Engineers, London Students' Section (joint meeting with the Association of London Graduates and Students of the Institution of Civil Engineers and the London Graduates' Section of the Institution of Mechanical Engineers, at the Institution of Civil Engineers, Great George Street, London, S W 1), at 6 30 p m —Sir Miles Thomas, D F C "Air Transportation"

Tuesday, March 15

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S W 1), at 5 30 p m —Annual General Meeting, followed by Dr G F J Garlick "The Luminescence of Solids in the Infra-Red Region"

Institution of Chemical Engineers (joint meeting with the Chemical Engineering Group, Society of Chemical Industry, at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Scientific Papers

Institution of Civil Engineers (at Great George Street, Westminster, London, S W 1), at 5 30 p m —Mr Jack Robertshaw and Mr P D Brown "Geophysical Methods of Exploration and their Application to Civil Engineering Problems"

Institution of Electrical Engineers, Measurements Section (at Savoy Place, London, W C 2), at 5 30 p m —Dr J C West and Mr J L Douce "The Mechanism of Sub-harmonic Generation in a Feedback System", Dr J C West and Mr P N Nikiforuk "The Transient Behaviour of Remote-Position-Control Systems with a Hard Spring Non-Linear Characteristic"

University of London (at King's College, Strand, London, W C 2), at 5 30 p m —Sir Frederic Bartlett, F R S "The Man and the Weapons" * (Further lecture on March 22)

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Prof R W Russell "The Importance of Human Communication in Industry" *

British Ornithologists' Union (in the Meeting Room of the Offices of the Zoological Society of London, Regent's Park, London, N W 1), at 6 p m —Annual General Meeting

Tuesday, March 15—Thursday, March 17

Oil and Colour Chemists' Association (at the Royal Horticultural Society's Old Hall, Vincent Square, London, S W 1)—Seventh Technical Exhibition *

Wednesday, March 16

Geological Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m —Mr A A Day, Dr M N Hill, Mr A S Laughton and Mr J C Swallow "Seismic Prospecting in the Western Approaches of the English Channel", Dr D W Powell "Gravity and Magnetic Anomalies in North Wales" (Paper will be read by Dr D H Griffiths)

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S W 7), at 5 p m —Scientific Papers *

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 15 p m —Dr D R Cox "Some Statistical Methods connected with Series of Events"

Institution of Electrical Engineers, Supply Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr R T Rushall and Mr J S Simons "An Examination of High-Voltage D C Testing Applied to Large Stator Windings"

Royal Microscopical Society (at Tavistock House, South, Tavistock Square, London, W C 1), at 5 30 p m —Mr E H Leach "Retinal Structure and Colour Vision"

Institution of the Rubber Industry, North Eastern Section (joint meeting with the Plastics Institute and the Royal Institute of Chemistry, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6 30 p m —Dr A Charlesby "The Effects of High Energy Radiations on Rubber and Plastics"

Society for Analytical Chemistry, Microchemistry Group (in the Restaurant Room of "The Feathers", Tudor Street, London, E C 4), at 6 30 p m —Discussion on "The Direct Determination of Oxygen in Organic Substances"

Society of Chemical Industry, London Section (joint meeting with the London Section of the Royal Institute of Chemistry, in the Chemistry Lecture Theatre, King's College, Strand, London, W C 2), at 6 30 p m —Dr H Baines "Recent Advances in Photography"

Thursday, March 17

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 15 p m —Meeting for Election of Fellows 4 30 p m —Prof M J Lighthill, F R S, and Mr G Whitham "Kinematic Waves 1 Flood Movement in Long Rivers 2 A Theory of Traffic Flow on Long Crowded Roads"

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 5 p.m —Mr J J Brummer "The Geology of the Roan Antelope Orebody", Mr J H Sinclair "Handling Ore and Waste at Irwin Shaft, Roan Antelope Copper Mine"

Linnean Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m —Meeting on "Chemical Analysis in Ecology Illustrated from Lake District Tarns and Lakes" Mr F J H Mackereth "Chemical Differences", Dr J W G Lund "Algal Differences", Dr T T Macan "Faunistic Differences" (Freshwater Biological Association)

University of London (at University College Hospital Medical School, London, W C 1), at 5 p m —Dr Honor Fell "The Response of Organs in Culture to Environmental Influences" *

Royal Aeronautical Society (at the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S W 1), at 6 p m —Monsieur Georges Hereil "Making Aeroplanes Independent of Runways" (Eighth Louis Bleriot Lecture)

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S W 1), at 6 p m —Dr J W Jeffery "The Practical Implications of Fundamental Research on Cement Hydration"

Society of Chemical Industry, Microbiology Group (in the Large Hall of the Medical Society of London, 11 Chandos Street, London, W 1), at 6 15 p m —Dr M Lumb "The Lesser Known Antibiotics"

British Glaciological Society (at Bedford College, Regent's Park, London, N W 1), at 7 30 p m —Mr P D Baird "Glacier Exploration in Arctic Canada"

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Prof E L Hirst, F R S "Some Problems in the Chemistry of the Hemicelluloses" (Pedler Lecture)

Royal Society of Tropical Medicine and Hygiene (at the Royal Army Medical College, Millbank, London, S W 1), at 7 30 p m —Laboratory Meeting

Friday, March 18

Society for Water Treatment and Examination (at the Main Offices of the Metropolitan Water Board, Rosebery Avenue, London, E C 1), at 9 30 a m —Annual General Meeting, followed by Scientific Papers

Institution of Mechanical Engineers (at 1 Birdcage Walk, London, S W 1), at 5 30 p m —Annual General Meeting

Aslib (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W C 2), at 6 p m —Discussion on "Recent Developments in the Universal Decimal Classification", led by Mr G A Lloyd

Society of Chemical Industry, Fine Chemicals Group (at the Westminster Medical School, 17 Horseferry Road, London, S W 1), at 6 p m —Discussion on "Chemical Aspects of Thyrotoxicosis"

British Society for the History of Science, Philosophy of Science Group—Northern Branch (in the University Staff House, The University, Manchester), at 7 p m —Dr Joseph Needham, F R S —"China's Philosophia Perennis , Organic Naturalism"

Saturday, March 19

Biochemical Society (at University College, Gower Street, London, W C 1), at 10 45 a m —Annual General Meeting, followed by Scientific Papers

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Research Assistants (2) (with a good honours degree in physics or physical chemistry) in the Department of Mining—The Registrar, The University, Leeds 2 (March 18)

Scientist, Grade 3 (with a good honours degree, or equivalent qualification in a science subject, and preferably with a sound background in geology and chemistry), at the Coal Survey Laboratory, Cardiff, for work which includes the preparation of detailed reports on the structure and physical and chemical properties of coal seams of South Wales, Bristol and Somerset, and Forest of Dean coalfields—The National Coal Board, Establishments (Personnel) Hobart House, Grosvenor Place, London, S W 1, quoting TT/932 (March 18)

Assistant Experimental Officer (with G C E (advanced) or a degree in botany or equivalent qualification) in the Unit of Plant Nutrition, Agricultural Research Council, Long Ashton, to assist in investigations on the effects of micro-nutrient elements on the growth of higher plants—The Secretary, Research Station, Long Ashton, Bristol (March 19)

Assistant (with an honours degree in chemistry or equivalent qualification, and preferably with teaching and/or industrial experience) at the College of Further Education, to teach chemistry up to final degree standard—The Director of Education, Education Office, Eleanor Street, Grimsby (March 19)

Scientific Officers (with a first- or second-class honours degree or equivalent in mathematics or mathematical physics) at the Royal Aircraft Establishment, Farnborough, Hants, for research and development on targets for guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 36/5A (March 19)

RESEARCH ASSISTANT (with a good degree in mining, engineering or pure science) TO THE PROFESSOR OF MINING—The Registrar, The University, Sheffield (March 26)

ASSISTANT LECTURER (preferably with interests in applied mathematics) IN THE DEPARTMENT OF MATHEMATICS—The Secretary, University College London, Gower Street, London, W C 1 (March 28)

LECTURERS (2) ON PHYSIOLOGY—The Registrar, King's College, Strand, London, W C 2 (March 28)

HEAD OF THE DEPARTMENT OF ENTOMOLOGY—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (March 31)

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Birmingham 15 (March 31)

PRINCIPAL SCIENTIFIC OFFICER (with an honours degree in botany or agricultural botany, and research experience) to act as head of a department conducting research on the ecology and improvement of hill vegetation and on grassland agronomy on hill farms—The Secretary, Hill Farming Research Organization, Broomhouse Drive, Edinburgh 11 (March 31)

SENIOR LECTURER (graduate in science or technology and with extensive research experience with fibres) IN PAPER-MAKING TECHNOLOGY—The Registrar, College of Technology, Manchester (March 31)

CHEMICAL PATHOLOGIST to the Hospital and LECTURER IN CHEMICAL PATHOLOGY to the Medical College—The Clerk to the Governors, St Bartholomew's Hospital, London, E C 1 (April 1)

ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Liverpool (April 2)

CHAIR OF APPLIED MATHEMATICS—The Registrar, The University, Sheffield 10 (April 2)

LECTURER IN EDUCATIONAL PSYCHOLOGY—The Registrar, The University, Liverpool (April 2)

RESEARCH OFFICER (with a university honours degree or higher qualifications with chemistry as a major subject) IN THE DIVISION OF FOREST PRODUCTS, Commonwealth Scientific and Industrial Research Organization, S Melbourne, to carry out fundamental and applied research in various chemical aspects of wood preservation against fungi, termites, borers and marine organisms, etc —Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2 (April 2)

LECTURER (Grade 2) or ASSISTANT LECTURER IN MATHEMATICS at University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W C 1 (April 7)

LECTURER IN BIOCHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (April 9)

SENIOR TECHNICAL OFFICER or PRINCIPAL TECHNICAL OFFICER (with a university degree in science or equivalent qualifications, and experience in the collection of samples and the complete analysis of coal) IN THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, Australia, to supervise the collection, preparation, testing and chemical analyses of coal samples in connexion with the Section's survey of the physical and chemical properties of Australian coals—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House Kingsway London, W C 2, quoting 480/152 (April 9)

ASSISTANT LECTURER (preferably with an interest in the geography of tropical regions and/or economic geography) IN GEOGRAPHY—The Secretary, University College London, Gower Street, London, W C 1 (April 12)

RESEARCH FELLOW IN THE DEPARTMENT OF GEOGRAPHY, Australian National University, Canberra—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, April 15)

ASSISTANT BIOCHEMIST (with a B Sc degree with honours in chemistry or biochemistry) IN THE GROUP PATHOLOGY LABORATORY—The Administrative Officer, Withington Hospital, Manchester 20

ASSISTANT CONSERVATOR (with a degree in forestry, and preferably under 40 years of age) OF FORESTS, Cyprus—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting BCD 61/17/01

ASSISTANT LECTURER IN AGRICULTURAL BOTANY—The Bursar, Royal Agricultural College, Cirencester Glos

ASSISTANT LECTURER IN GEOLOGY—The Registrar, The University, Nottingham

LABORATORY TECHNICIAN (with experience and skill in general bacteriological methods, and preferably with special experience in methods applicable to studies on viruses and tissue culture work)—The Secretary, The Foot-and-Mouth Disease Research Institute, Pirbright, Surrey

LECTURER (Grade B) IN PHYSICS—The Clerk to the Governing Body, Battersea Polytechnic, London, S W 11

LECTURER IN MECHANICAL ENGINEERING, with special reference to the rubber and plastic industries—National College of Rubber Technology, Northern Polytechnic, Holloway, London, N 7

PHYSICIST (with a degree in physics and preferably some industrial or research experience) IN THE FLUID DYNAMICS SECTION of the Physics Department in the Association's Laboratories in London, for work mainly on the treatment of gases and aerosols—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1, quoting "Fluid Dynamics"

RESEARCH ASSISTANT (with a good technical qualification or scientific training, and preferably some experience of vacuum technique or electronics) IN THE RESEARCH LABORATORY ON THE PHYSICS AND CHEMISTRY OF SURFACES, for work involving the maintenance, application and development of an electron microscope and diffraction camera, used in the research programme of the laboratory—The Secretary, P C S Laboratory, Department of Physical Chemistry, Free School Lane, Cambridge

SENIOR LECTURER IN GEOLOGY, specializing in Stratigraphy-Palæontology—The Dean, College of Arts and Sciences, Baghdad, Iraq

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Air Ministry Meteorological Office Handbook of Weather Messages Part 3 Coding, Decoding and Plotting Second edition Pp vii+115 (M O 510c) (London H M Stationery Office, 1954) 4*s* 6*d* net [2112

Privy Council Medical Research Council Memorandum No 30 The Use of Trilene by Midwives By the Committee on Analgesia in Midwifery Pp vi+34 (London H M Stationery Office, 1954) 2*s* net [2112

Forestry Commission Forest Record No 29 The Use of Forest Produce in Sea and River Defence in England and Wales By J R Aaron Pp 26 1*s* 6*d* net Bulletin No 22 Experiments in Tree Planting on Peat By J W L Zehetmayr Pp iv+110+16 plates 10*s* net Report on Forest Research for the year ending March, 1953 Pp vi+122+9 plates 5*s* net (London H M Stationery Office, 1954) [2112

The Health of the School Child Report of the Chief Medical Officer of the Ministry of Education for the years 1952 and 1953 Pp 150 (London H M Stationery Office, 1954) 5*s* net [2112

Luminescence, with particular reference to Inorganic Phosphors (A symposium held by the Electronics Group of the Institute of Physics at the Cavendish Laboratory, Cambridge, from the 7 to 10 April, 1954) (*British Journal of Applied Physics* Supplement No 4) Pp iv+120+iv (London Institute of Physics, 1954) 25*s* [2112

Ministry of Education Early Leaving a Report of the Central Advisory Council for Education (England) Pp vii+99 (London H M Stationery Office, 1954) 3*s* 6*d* net [2312

Air Ministry Meteorological Office Geophysical Memoirs No 93 Variation of Wind with Time and Distance By C S Durst Pp 32 (M O 584a) (London H M Stationery Office, 1954) 4*s* 6*d* net [2312

Other Countries

Pontificia Academia Scientiarum Scripta Varia No 11 Ein Vorschlag zur Empirischen Reduktion von Spektralverteilungen Von Joseph Junkes S J Pp 240 Scripta Varia No 12 Semaine d'Étude sur le Problème des Microséismes Pp xlvi+417+5 plates (Città del Vaticano Pontificia Academia Scientiarum, 1952) [1712

Pontificia Academia Scientiarum Commentationes Anno 15, Vol 15 No 1 Intorno alla Costituzione e alla Genesi di Piede Malformazioni Teratologiche del Piede di *Anodonta mutabilis* Clessin Di Carlo Piersanti Pp 28+15 plates No 2 Fenomenologia e Interpretazione di After-effects nella Cinestesia Di Leonardo Ancona Pp 29–72 No 3 Alcuni Aspetti di Psicologia di Gruppo in un Ambiente di Lavoro Industriale Di Franca Magistretti Pp 73–124 No 4 Adattamento Italiano del Reattivo Wechsler-Bellevue per la Valutazione dell' Intelligenza Di Marcello Cesa-Bianchi e Angelo Perugia Pp 125–192 No 5 Studio su Alcuni Aspetti della Frustrazione Sociale Di Franca Magistretti Pp 193–232 (Città del Vaticano Pontificia Academia Scientiarum, 1951–1953) [2112

Anuario del Observatorio Astronomico de Madrid, para 1955 Pp 429+2 plates (Madrid Observatorio Astronomico, 1954) 40 pesetas [2112

American Association for the Advancement of Science, and Participating Affiliated and Associated Societies General Program-Directory of the Berkeley Meeting (The 121st Meeting of the Association—the Annual Meeting for the year 1954, held on the Campus of the University of California, December 26–31, 1954) Pp 420 (Washington, D C American Association for the Advancement of Science, 1954) [2112

Arbeitsgemeinschaft fur Forschung des Landes Nordrhein-Westfalen Heft 38 Kybernetik die Beziehung zwischen Mensch und Maschine Von Dr E Colin Cherry Dokumentation und mechanisches Gedächtnis zur Frage der Ökonomie der geistigen Arbeit Von Prof Dr Erich Pietsch Pp 96 (Koln und Opladen Westdeutscher Verlag, 1954) 7 20 D marks [2112

Pontificia Academia Scientiarum Commentationes Anno 16, Vol 16, No 2 Analisi Elettroacustica della Voce Cantata Di A Gamelli G Sacerdote e G Bellussil Pp 21–44+19 plates (Città del Vaticano Pontificia Academia Scientiarum, 1954) [2112

Rijkslandbouwhogeschool Zesde Jaarlijks Symposium over Phytopharmacie, 4 Mei 1954 (Overgedrukt uit "Mededelingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent" 1954, Band 19 Nr 3) Pp ii+311–602 (Gent Coupure Links, 1954) [2112

FAO Nutritional Studies No 13 Síndrome Policarencial Infantil (Kwashiorkor) and Its Prevention in Central America By Dr Marcel Autret and Dr Moise Behar Pp vi+81+6 plates (Rome Food and Agriculture Organization of the United Nations, 1954) 1 dollar , 5*s* [2112

University of Illinois—Department of Mining and Metallurgica Engineering Shore Scleroscope Hardness Tests Made on Mohs' Scale Minerals from Talc to Quartz, inclusive By Bruce W Gilbert Pp 21 (Urbana, Ill University of Illinois, 1954) [2112

South Australia Institute of Medical and Veterinary Science Fifteenth Annual Report of the Council, July 1952–June 1953 Pp 111 (Adelaide Institute of Medical and Veterinary Science, 1954) [2112

Egypt Ministry of Commerce and Industry Mines and Quarrie Department Geological Survey Geology of the Naba District B Dr M S Amin, M S Mansour, M L A Kabesh and D M El-Far Pp xi+51+8 plates P T 120 Geology of Atud District By Dr M S Amin, A H Sabet and A O S Mansour Pp ix+79+18 plates P T 135 (Cairo Government Press, 1953) [211

Department of the Army—Corps of Engineers Beach Erosio Board—Office of the Chief of Engineers Technical Memorandu No 45 Modification of Wave Height due to Bottom Friction, Percolation, and Refraction By C L Bretschneider and R O Reid Pp v+36 Technical Memorandum No 56 An Electronic Wav Spectrum Analyzer and Its Use in Engineering Problems Pp iv+91 (Washington, D C Beach Erosion Board, Corps of Engineers 1954) [211

New Books

Radiobiology Symposium 1954

Edited by Professor Z M BACQ, University of Liège, and P ALEXANDER, Ph D , Chester Beatty Research Institute

This volume contains the papers which were presented at the meeting held in Liège in August–September, 1954, together with the discussions which arose from them The meeting was attended by scientists from twelve countries, and the majority of the papers report new experimental work Price 60*s*

Fundamentals of Radiobiology

By Professor Z M BACQ, University of Liège, and P ALEXANDER, Ph D , Chester Beatty Research Institute.

This book, written by a biologist and a physical chemist in collaboration, presents a balanced and coherent account of our present state of knowledge of radiobiology The importance of the subject for radiotherapists using radiation in the treatment of cancer, the necessity of avoiding the hazards to the health of the community in this age of nuclear fission, and the value of radiation in fundamental research on the cell have caused a great increase of late years in the number of those engaged in radiobiology, and this number is rapidly increasing This survey of the field as a whole therefore appears at an opportune time It will enable the specialist to assimilate developments in fields adjacent to his own and appreciate their possible effects on his particular work, and will provide those newly entering the field with a guide and an assessment of the present state of research Price 40*s*

BUTTERWORTHS SCIENTIFIC PUBLICATIONS
88 KINGSWAY LONDON W.C.2

The Policy for Children

£12 a year invested for a child will provide benefits at age 18, 21, or 25. The investment may be made by a parent or friend.

e.g. If the investment is begun within two months of birth it will provide, at age 21, £323 in cash, or a life policy for £1,656.

The Equitable Life Assurance Society

(founded 1762)

19, Coleman Street, London, E C.2.

No shareholders No commission.

L. LIGHT & CO. LTD.

Latest additions to our list—

Allyl glycidyl ether	75/– H
Allyl phenyl ether ($C_6H_5O\,CH_2\,CH\,CH_2$)	61/– H
Atrolactic acid (1-phenyl-lactic acid)	17/– G
Bis (trifluoromethyl) benzene	38/– H
Bitolylene di-*iso* cyanate	32/– H
Bixin (norbixin methyl ester)	49/– G
Boron, amorphous (90%)	13/– D
o-Bromobenzaldehyde	48/– D
m-Bromobenzaldehyde	45/– D
p-Bromobenzaldehyde	51/– D
D-Carvone ($\Delta^{1,8}$-p-menthadienone-6)	56/– H
p-Chloro-benzyl cyanide	22/– H
DL-*p*-Chloro-phenylalanine	42/– G
6-Chloro-pyridine-3-carboxylic acid	26/– D
p-Chloro-thiophenol	48/– H
Crotyl alcohol (1-hydroxy-2-butylene)	30/– D
N-Crotyl aniline	31/– D
Crotyl bromide	30/– D
cyclo-Hexane-1, 3-diol (hexahydroresorcinol)	10/– D
2-*cyclo*-Hexenone	64/– D
*cyclo*Pentadecanone (exaltone)	22/– G
1,2-Diamino-naphthalene	28/– D
Dianisidine di-*iso*cyanate	32/– H
5,5′-Dibromo-2,2′-dihydroxybenzil (dibromsalicil)	38/– D
1,3-Difluoro-4,6-dinitrobenzene	16/– D

POYLE TRADING ESTATE, COLNBROOK
near SLOUGH . BUCKS . ENGLAND
Telephone · *Colnbrook* 262/3

LECTURES AND COURSES

CHELSEA POLYTECHNIC
MANRESA ROAD, S W 3
(Telephone FLAxman 5747)

Full-time courses and part-time day and evening courses are arranged in biology, botany, chemistry, geology, mathematics, physics, physiology, zoology, in preparation for the preliminary (intermediate) science examination and the B Sc general degree of the University of London for internal and external students, and for professional examinations Full-time or part-time courses are also held for the B Sc internal special or honours degrees in botany, chemistry (full-time only) geology, mathematics, pharmacy, physics, physiology (evening only) and zoology Facilities are provided for research and postgraduate study and short courses of lectures are held on special topics Full-time courses are arranged for professional qualifications in pharmacy and chiropody There are special evening courses in food and drugs, gemmology, industrial microbiology, and surgical technicians' work

Applications for enrolment for the Session 1955-6 may now be made on forms to be obtained from the Principal

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952

COMMONWEALTH of AUSTRALIA
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
APPOINTMENT OF SENIOR BIOCHEMIST
DIVISION OF PLANT INDUSTRY

The Division of Plant Industry proposes to appoint a leader for its research team in biochemistry which at present consists of seven research and technical officers The appointee is to reorganize and develop a research programme in fields of relevance to basic problems of plant growth There will be opportunities for collaborative research with workers in physiology, microbiology and genetics The appointee will be stationed at the main laboratories in Canberra Salary Dependent on qualifications and experience, commencing salary will be determined within the range of Principal Research Officer, £A 2,228 to £A 2,588, £A 90 increments, subject to efficiency review at £A 2,408 or Senior Principal Research Officer, £A 2,678 to £A 3,000 (three salary steps) subject to efficiency review at £A 2,678 Note The above salaries refer to a male appointee The appointment will be conditional on a satisfactory medical examination The appointee may be granted superannuation privileges Fares to Australia (including those of wife and family) will be paid

Applications, stating full name, place, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by the names and addresses of two persons willing to act as referees, if required and by copies of not more than four testimonials, should reach the undersigned not later than April 9, 1955 The Chief of the Division of Plant Industry, Dr O H Frankel F R S, will be arriving in England in the middle of April

W IVES,
Chief Scientific Liaison Officer
Australian Scientific Liaison Office
Africa House,
Kingsway, London, W C 2

CIVIL SERVICE COMMISSION
DUBLIN
VACANCIES FOR ESTABLISHED CHEMISTS

Salary scale (Man) £485 to £1,118 Two vacancies at Johnstown Castle Agricultural College (under Department of Agriculture), for persons under 40 years with an honours university degree in chemistry or biochemistry, or an equivalent academic qualification , and one vacancy in the State laboratory for a person under 35 years with an honours university degree in chemistry or an equivalent academic qualification , and satisfactory experience of analytical or research work in a chemical laboratory Extensions of either agelimit in certain cases

Application forms and further particulars from the Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin Latest date for receiving completed application forms, March 22, 1955

COMMONWEALTH of AUSTRALIA
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
APPOINTMENT OF HEAD OF CHEMISTRY/PHYSIOLOGY GROUP
DIVISION OF PLANT INDUSTRY

The Division of Plant Industry is responsible for research into the problems basic to plant growth and production in Australia Its Chemistry/Physiology Group conducts investigations in plant physiology, biochemistry, plant chemistry and related disciplines The Division now proposes to appoint as leader for this Group a scientist distinguished in one of its fields of interest and invites applications or inquiries There will be opportunities for collaboration with other Groups in the Division engaged in research in a variety of biological fields, and it is hoped that the appointee in this and other ways will contribute leadership and inspiration for the researches of the Division as a whole There will be ample opportunities for personal research The Division maintains close contact with research in Australian universities The appointee will be stationed at the main laboratories in Canberra Salary The commencing salary will be determined within the range of Senior Principal Research Officer, £A 2,678 to £A 3,000 (three salary steps) subject to efficiency review at £A 2,678 or Chief Research Officer, Grade 1, £A 3,200 , Grade 2, £A 3,400 The appointment will be conditional on a satisfactory medical examination The appointee may be granted superannuation privileges Fares to Australia (including those of wife and family) will be paid

Applications stating full name, place, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by copies of not more than four testimonials and the names and addresses of at least two persons willing to act as referees, if required, should reach the undersigned not later than April 9, 1955 The Chief of the Division of Plant Industry, Dr O H Frankel, F R S , will be arriving in England in the middle of April

W IVES,
Chief Scientific Liaison Officer
Australian Scientific Liaison Office,
Africa House,
Kingsway, London W C 2

UNIVERSITY COLLEGE OF KHARTOUM
SUDAN

Applications are invited for (1) Readership and/or Senior Lectureship in Mechanical Engineering (2) Lectureship or Assistant Lectureship in Mechanical Engineering (3) Senior Lectureship, Lectureship or Assistant Lectureship in Civil Engineering or Surveying Salaries Reader £E 2,170 per annum, Senior Lecturer £E 1,600 by £E 75 to £E 1,975 per annum, Lecturer £E 1,150 by £E 75 to £E 1,675 per annum, Assistant Lecturer £E 1,000 by £E 75 to £E 1,150 per annum Point of entry according to qualifications and experience Cost of living allowance now approximately £E 150 per annum Outfit allowance £50 on first appointment Passages for appointee and family on appointment, termination and leave (each long vacation after first) Appointment on contract for three to seven years (renewable) with bonus on completion (one month's salary for each year of service) No income tax at present payable in Sudan

Detailed applications (eight copies), naming three referees, to be received by April 7, by Secretary, Inter-University Council, 1 Gordon Square, London, W C 1, from whom further information may be obtained

SOUTH-WEST ESSEX TECHNICAL COLLEGE
AND SCHOOL OF ART
Forest Road, Walthamstow, E 17

The Governors invite applications for two Research Assistantships in Physical Chemistry, one to begin immediately, and the other in September, 1955 Stipend £350 per annum Candidates will be expected to prepare for a higher degree

Applications by letter should be made to the Clerk to the Governors at the College

---

UNIVERSITY COLLEGE LONDON (GOWER Street, W C 1) requires Assistant Lecturer in Department of Mathematics , preference will be given to applicants whose interests are in applied mathematics Duties to commence October 1, 1955 Salary £600 to £700 per annum, according to qualifications and experience Superannuation and family allowance —Applications, to be received by March 28, should be sent to the Secretary from whom further particulars may be obtained

COMMONWEALTH of AUSTRALI
APPOINTMENT NO 370/90 OF PHYSICI OR METALLURGIST THREE-YEAR PERIC
DIVISION OF TRIBOPHYSICS

The Commonwealth Scientific and Industr Research Organization invites applications fr physicists or metallurgists for appointment to position of Research Officer to work with t solid state group of the Division of Tribophysi located at the University of Melbourne T group is concerned with problems of plastic formation and phase transformations Initial the appointment will be made for a period three years but it may be extended Qualifi tions Research experience at least equivalent Ph D standard is essential Some experience the field of nuclear magnetic resonance would an advantage Salary Dependent on qualifi tions and experience, commencing salary will determined within the range of Research Offic £A 1,184 to £A 1,730 per annum and an app cant would be appointed at a commencing sala of not less than £A 1,394 per annum, accordi to qualifications and experience Fare Australia (including those of wife and family) w be paid also return fares in cases where t appointee does not take up permanent appoi ment with C S I R O at the expiry of his fix period

Applications, referring to Appointment N 370/90, and stating full name, place, date a year of birth, marital state, nationality, particul of qualifications and experience, and of war s vice, if any, accompanied by the names and a dresses of at least two persons willing to act referees, if required and copies of not more th four testimonials, should reach the undersign not later than April 23, 1955

W IVES,
Chief Scientific Liaison Offic
Australian Scientific Liaison Office,
Africa House,
Kingsway, London, W C 2

UNIVERSITY COLLEGE
IBADAN

Applications are invited for post of Seni Laboratory Technician in Department of Anato from qualified technicians with special training embryology and histology Appointment (th years in first instance) to commence as soon possible Salary scale £850 by £25 to £950 p annum Point of entry determined by qualific tions and experience Child allowance £50 p annum per child (maximum £150 per annum) f children resident in Nigeria or £100 per annum p child (maximum £300 per annum) for childr resident elsewhere Outfit allowance £60 on fi appointment Passages paid for member of sta wife and children (under 11 years) on appointme overseas leave and termination Basic tour 15 18 months Partly furnished accommodation rent not exceeding 7 7 per cent of salary Pensi scheme

Applications (six copies), naming three refer and stating full qualifications and experience, be received by April 7 by Secretary, Int University Council for Higher Education Ov seas, 1 Gordon Square, London, W C 1, fr whom further particulars may be obtained

BRITISH RAYON RESEARCH ASSOCIATION

The Association has a number of vacancies Physicists or Physical Chemists on the resea staff The work will involve both fundame and applied research on textile fibres and rela materials Applicants should have a good hono degree, preferably with some research experie not necessarily in textiles

Applications, with full details and names of referees, should be addressed to the Appointm Officer, British Rayon Research Associati Heald Green Laboratories, Wythenshawe, M chester

UNIVERSITY OF SHEFFIELD

Applications are invited for the Chair Mechanical Engineering Salary not less t £2 300 a year, with F S S U provision and far allowance

Further particulars should be obtained from Registrar, the University, Sheffield, 10 to wh applications should be sent by April 30, 1955

UNIVERSITY COLLEGE
EXETER

Temporary Lecturer or Assistant Lecturer Mathematics Salary within the range £550 £750 per annum The appointment is for year only, starting October 1, 1955

Further information obtainable from the Se tary Closing date for applications April 1955

THE POLYTECHNIC

309 REGENT STREET, W 1

DEPARTMENT OF CHEMISTRY AND BIOLOGY

he following full-time posts are available as m September 1, 1955 (1) Lecturer to teach siology to final degree standard Candidates uld possess a good honours degree and have l previous teaching experience to this level ary scale £965 by £25 to £1,065, plus London wance of £36 or £48 per annum (2) Grade B her with qualifications in chemistry and logy to teach these subjects to general certifi- of education (advanced level) standard (3) de B teacher with qualifications in chemistry botany to teach these subjects to general cer- ate of education (advanced level) standard salary scale for posts (2) and (3) is £525 £25 to £820, plus degree allowance £60, and don allowance, £36 or £48 (men) and £475 by to £655, plus degree allowance £48 and don allowance, £36 or £48 (women) Addi- al allowances are payable in both cases for roved study or training and for a good ours degree Increments on the scale may allowed in respect of previous teaching or pro- onal experience

form of application which should be re- ed by April 18, 1955 may be obtained by ding a stamped addressed foolscap envelope the undersigned

J C JONES
Director of Education

UNIVERSITY COLLEGE

IBADAN

pplications are invited for (1) Lectureship ade II) or (2) Assistant Lectureship in Mathe- tics Duties (to be assumed October 1, 1955) include teaching applied mathematics to cial degree students Appointment for three rs in first instance Salary scales (1) £900 £50 to £1,200 per annum (2) £750 by £50 to 0 per annum Point of entry determined by lifications and experience Child allowance per annum per child (maximum £150 per num) for children resident in Nigeria or £100 annum per child (maximum £300 per annum) children resident elsewhere Outfit allowance on first appointment F S S U Passages d for member of staff, wife and children (under years) on appointment annual leave and nination Part furnished accommodation at not exceeding 7 7 per cent of salary

pplications (six copies), naming three referees stating full qualifications and experience to be ived by April 7, 1955, by Secretary, Inter- versity Council for Higher Education Overseas, ordon Square, London W C 1, from whom her particulars may be obtained

---

NIVERSITY OF NOTTINGHAM

SCHOOL OF AGRICULTURE

aboratory Technician required to develop a oratory workshop and to assist in routine re- ch and class preparation Preference will be n to applicants with experience in instrument king Salary scale £340 by £15 to £415 (bar) 0 by £20 to £480 per annum

pply Secretary University of Nottingham ool of Agriculture Sutton Bonington Lough- ough

---

NIVERSITY OF MANCHESTER

pplications are invited for the posts of Lec- r in Astronomy and two Lecturers in Radio- ronomy Salary on a scale £500 to £1 100 annum, initial salary according to qualifica- s and experience (Salary scales are at present er review) Membership of F S S U and dren s allowance scheme

pplications should be sent not later than rch 26, 1955 to the Registrar, The University nchester 13 from whom further particulars forms of application may be obtained

---

TIONAL COLLEGE OF RUBBER TECHNOLOGY

RTHERN POLYTECHNIC, HOLLOWAY, LONDON, N 7

he Board of Governors invite immediate lications for appointment as Lecturer in hanical Engineering with special reference to rubber and plastic industries Candidates uld possess an engineering qualification with erience of rubber or a diploma in rubber nology with engineering experience Salary le, £1,015 by £25 to £1,115

orm of application, together with full particu- , will be sent on receipt of a stamped, ad- ssed foolscap envelope

R H CURRELL, A S A A,
Clerk

BRITISH CAST IRON RESEARCH ASSOCIATION

has vacancies on its Research Staff for men aged 22-35 qualified in any of the following metallurgy, physics, chemistry, engineering Experience in connection with iron-founding not essential An excellent avenue of approach is provided to a career n an enterprising industry The investigators are required for work on dephosphorization (involving considerations of ore beneficiation, blast furnace practice, top blowing, slag/metal reaction, cupola operation, etc), solidification mechanisms melting furnace operation, graphite formation, mould/metal reactions, moulding sands, the properties of cast iron at elevated temperatures, and other subjects Facilities are available for fundamental and for applied work Ample opportunity for travel, for continuous contact with industry, and ultimate employment within the industry The salaries will follow those of the Scientific Civil Service, and appointments will normally be in the Scientific Officer (£445 to £815 per annum), Senior Scientific Officer (£935 to £1 090 per annum) and Principal Scientific Officer (£1,090 to £1,472 per annum) grades, but special qualifications will receive consideration The Association is situated in the country, within easy reach of Birmingham and Redditch Superannuation

Applications to the British Cast Iron Research Association, Alvechurch, Birmingham, giving age, qualifications and experience

---

NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

ASSISTANTSHIPS IN BACTERIOLOGY

Applications are invited for two vacancies in the Department of Bacteriology, and preference will be given to candidates with an honours degree in bacteriology or an equivalent qualification The successful candidates will be required to take part in the lecturing and advisory work of the department, and will be appointed to one of the following salary scales, with entry according to qualifications and experience Grade III, £596 2s to £936 14s (men) £515 10s to £811 6s (women) Grade IV(a) £440 6s to £596 2s (men), £440 6s to £527 4s (women) Grade IV(b), £419 2s to £596 2s (men), £4 9 2s to £527 4s (women) An opportunity will be available for investigational work and there is a superannuation scheme The successful candidates must be prepared to serve in any part of the College area

Further details and application forms may be obtained from the undersigned, with whom applications should be lodged not later than March 26, 1955

HUGH MUNRO,
Secretary

41½ Union Street,
Aberdeen

BIRKBECK COLLEGE

(UNIVERSITY OF LONDON)

Applications are invited for the following Assistant Lectureships Applied Mathematics Chemistry, with special reference to inorganic chemistry Organic Chemistry Geology, candidates should have special interests n palaeontology Psychology, candidates should have had experience of vocational guidance and time and motion study The scale of salary in each post will be £600 by £50 to £700 per annum

Further particulars should be obtained from the Secretary Birkbeck College, Malet Street W C 1 Closing date for applications April 9, 1955

UNIVERSITY OF BIRMINGHAM

ELECTRICAL ENGINEERING DEPARTMENT

Applications are invited for a Lecturer in Electrical Engineering (Grade II £650 by £50 to £1,350, according to qualifications and experience) Duties to commence as soon as possible There would be some preference for a candidate with industrial experience in electrical machinery or electric power

Three copies of applications, with the names of three referees, should reach the Registrar, The University Birmingham, 15, not later than March 31 1955 Further particulars may be received from the undersigned

G L BARNES
Secretary

The University,
Birmingham, 15

PROVINCIAL ADMINISTRATION OF THE CAPE OF GOOD HOPE

HOSPITALS DEPARTMENT

HOSPITAL BOARD SERVICE VACANCY

Applications are invited from suitably qualified applicants for appointment to the following vacant post at Groote Schuur Hospital, Observatory, Cape Town Technician, Grade B (E E G, Radiological Department) with salary on the scale £660 by £30 to £750 to £786 per annum In addition to the salary indicated a cost of living allowance at rates prescribed from time to time by the Administrator is payable The present rate is £234 for married male official and employees Conditions of service are prescribed in terms of Hospital Board Service Ordinance No 19 of 1941, as amended, and the regulations framed thereunder Candidates must be qualified radiographers and must be able to perform electroencephalographic duties The successful applicant will be required to submit satisfactory birth and health certificates and his/her appointment will be subject to the following conditions (i) Appointment will be on contract for five years in the case of a citizen of a Commonwealth country or the Republic of Ireland and six years in the case of a citizen of European countries other than the United Kingdom and the Republic of Ireland (ii) Transport expenses (third class by rail overseas and second or cabin class steamship fare and first-class by rail in the Union) necessarily incurred by the successful applicant from place of residence to the place of assumption of duty in South Africa, will be defrayed by the Administration provided that, if the contract is broken within one year of the date of assumption of duty the person appointed must refund to the Administration the full amount paid in respect of transport expenses and if the contract is broken within five years of the date of assumption of duty in the case of a Commonwealth citizen and six years in the case of a citizen of another European country, the person appointed shall refund to the Administration the pro rata share of the full amount above referred to in respect of the unexpired period (iii) The person so appointed will be offered permanent appointment during the term of contract but not earlier than three years from the date of assumption of duty or with effect from the conclusion of the contract, provided he has passed an examination in Afrikaans as second language, which examination shall not be lower than the standard required for the junior certificate examination of the Department of Education of this Province and provided further that his services and conduct during the period of contract are satisfactory and his state of health is such as will enable him to continue to discharge efficiently all the duties of the post in which he will be employed

Application must be made on the prescribed form, Staff 23, which is obtainable from the Staff Clerk, Room 102, South Africa House, Trafalgar Square, London, W C 2 The completed application forms must be addressed to the Director of Hospital Services, P O Box 2060, Cape Town South Africa, and must reach him not later than April 5, 1955 Candidates must state the earliest date on which they can assume duty

---

BIRKENHEAD EDUCATION COMMITTEE

BIRKENHEAD TECHNICAL COLLEGE

(Principal C V Vinten Fenton, M Sc, A M I E E, A M I Mech E)

Applications are invited for the following full-time appointments, commencing as soon as possible Assistant Grade B, Mechanical Engineering general subjects, Naval architecture or chemical engineering an additional qualification Assistant Grade A, Mechanical Engineering, motor vehicle technology and allied subjects, also engineering workshop subjects Salaries in accordance with Burnham Technical Scale

Further particulars and application forms from the undersigned, to whom completed applications should be returned within fourteen days of the appearance of this advertisement

H GLYN WILKINSON
Director of Education

63 Hamilton Square, Birkenhead

UNIVERSITY OF MANCHESTER

Applications are invited for an Assistant Lecturer in Botany Candidates should have special interests in mycology Salary on a scale £450 to £550 per annum, with membership of F S S U and children's allowance scheme (salary scales at present under review)

Forms of application and further particulars may be obtained from the Registrar The University, Manchester 13 to whom applications should be sent as soon as possible, but not later than March 16, 1955

COMMONWEALTH of AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

APPOINTMENT NO 121/122 OF LIBRARIAN (MALE OR FEMALE), CANBERRA A C T

Applications are invited for appointment to a position of Librarian to take charge of a technical library serving the Division of Entomology, Division of Plant Industry and the Land Research and Regional Survey Section of C S I R O Of a total research staff of 130 the greater proportion is located in Canberra itself but there are also 20 Field Stations throughout Australia for whose library service the librarian in Canberra is largely responsible The library's functions includes an over-all reference service, the compilation of bibliographies and the dissemination of information to officers of the above groups Qualifications Applicants must possess a university degree in science and the qualifying certificate of the Library Association of Australia, or its equivalent It is essential that they should have had experience in a technical library Salary Dependent on qualifications and experience, commencing salary will be determined within the range of Librarian Grade II £A 1,142 to £A 1,310 per annum actual, four increments Note (a) The above salaries apply to a male appointee (b) Salary for a female appointee will be £A 154 per annum less than a corresponding male actual salary Fare to Australia (including those of wife and family) will be paid The appointment is subject to a satisfactory medical examination and the appointee may be granted superannuation privileges

Applications, referring to Appointment No 121/122 and stating full name, place, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by names and addresses of at least two persons willing to act as referees, if required and copies of not more than four testimonials, should reach the undersigned not later than May 7 1955

W IVES,
Chief Scientific Liaison Officer
Australian Scientific Liaison Office
Africa House,
Kingsway, London, W C 2

UNIVERSITY COLLEGE OF KHARTOUM

SUDAN

Applications are invited for (1) Senior Lectureship or (2) Lectureship in each of the following Anatomy, Physiology, Anaesthetics, Medicine Salary scales Anatomy and Physiology, (1) £E 1,675 by £E 75 to £E 1,975 to £E 2,090 per annum (2) £E 1,225 by £E 75 to £E 1,750 per annum Anaesthetics and Medicine, (1) £E 1,750 by £E 75 to £E 1,975 to £E 2,090 to £E 2,170 per annum (2) £E 1,300 by £E 75 to £E 1,825 per annum Point of entry determined by qualifications and experience Cost of living allowance now approximately £E 150 per annum Outfit allowance £50 on first appointment Passages for appointee and family on appointment, termination and leave (each long vacation after first) Appointment on contract for three to seven years (renewable) with bonus on completion (one month's salary for each year of service) No income tax at present payable in Sudan

Detailed applications (eight copies), naming three referees, to be received by April 15, 1955, by Secretary, Inter-University Council, 1 Gordon Square London, W C 1 from whom further information may be obtained

---

BATTERSEA POLYTECHNIC

LONDON, S W 11

Applications are invited for a Grade B Lecturer to teach science to students of catering and allied subjects Applicants should be graduates of a British university with chemistry as one of their subjects Salary men £621 or £633 by £25 to £928, women £559 or £571 by £20 to £763, plus allowance of £30 and £24 respectively for a good honours degree a training allowance and increments for industrial or research experience

Further particulars from the Clerk to the Governing Body, by whom applications should be received as soon as possible

---

SOUTH MANCHESTER H M C, GROUP Pathology Laboratory, Withington Hospital, Manchester, 20 Applications are invited for the post of Assistant Biochemist (basic grade) Candidates should possess a B Sc degree with honours in chemistry or biochemistry, previous experience in hospital biochemistry not essential Whitley Council salary and conditions of service —Applications, stating age qualifications, experience, together with the names of two referees should be addressed to the Administrative Officer at the hospital as soon as possible

---

TEES VALLEY WATER BOARD

APPOINTMENT OF ASSISTANT CHEMIST

Applications are invited for the post of Assistant Chemist at a salary of £625 to £725 per annum (Grade APT III of the National salary scales) The work will involve both chemical and bacteriological analyses of water under the supervision of the chief chemist, and work outside the laboratory and in the field Applicants must hold a degree in chemistry of a British university and/or be Associates of the Royal Institute of Chemistry Some knowledge of biology will be an advantage The successful applicant must devote his whole time to the work of the Board and will be required to pass a medical examination The appointment will be subject to the provisions of the Local Government Superannuation Acts

Applications, stating age, qualifications and experience, accompanied by three recent testimonials should reach the undersigned not later than March 31, 1955

T S R WINTER, M I C E, A M I W E,
Engineer and General Manager
Water Board Offices,
Corporation Road, Middlesbrough

HILL FARMING RESEARCH ORGANIZATION

HILL FARMING AGRONOMIST

The Organization require a PRINCIPAL SCIENTIFIC OFFICER to act as head of a department conducting research on the ecology and improvement of hill vegetation and on grassland agronomy on hill farms Candidates should have an honours degree in botany or agricultural botany and have research experience Salary scale £1,120 to £1,521, plus pay supplement Superannuation F S S U

Applications, with names and addresses of two referees, not later than March 31, 1955, to the Secretary, Hill Farming Research Organization, Broomhouse Drive, Edinburgh, 11, from whom further details may be obtained

---

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Lecturer in Biophysics The post is newly established and applicants should have had experience in Electron Microscopy Salary on a scale £650 by £50 to £1,350 per annum, initial salary according to qualifications and experience Membership of F S S U and children's allowance scheme

Applications should be sent not later than April 11, 1955, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained

---

EXPERIMENTAL OFFICERS AND ASSISTant Experimental Officers in various Government Departments The Civil Service Commissioners invite applications for pensionable posts Applications may be accepted up to December 31, 1955, but forms should be returned as soon as possible as an earlier closing date may be announced either for the competition as a whole or in one or more subjects Applications from meteorologists must be received by May 31, 1955 Interview Boards will sit at frequent intervals The posts are divided between following main groups and subjects (a) mathematical and physical sciences, (b) chemistry and metallurgy, (c) biological sciences, (d) engineering subjects, and (e) miscellaneous (including, e g, geology, library and technical information services) Age limits For Experimental Officers, at least 26 and under 31 on December 31, 1955, for Assistant Experimental Officers at least 18 and under 28 on December 31 1955 Extension for regular service in H M Forces Candidates aged 31 or over with specialized experience for Experimental Officer posts may be admitted Candidates must have at least one of a number of specified qualifications Examples are, higher school certificate, general certificate of education, Scottish leaving certificate, Scottish universities preliminary examination, Northern Ireland senior certificate (all in appropriate subjects and at appropriate levels) higher national certificate, university degree Candidates taking their examinations in 1955 may be admitted Candidates without such qualifications may be admitted exceptionally on evidence of suitable experience In general a higher standard of qualification will be looked for in the older candidates than in the younger ones Salary (London) Experimental Officer £750 to £920 (men), £650 to £790 (women) Assistant Experimental Officer, £302 (at age 18) to £670 (men), £570 (women) Starting pay up to £545 (men) or £512 (women) at 26 Somewhat lower outside London Promotion prospects —Further particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W 1, quoting No S94-95/55

READER AND SENIOR LECTURERS OR Lecturers in Physics —The Dean, College of Arts and Science Baghdad Iraq

---

BIRKENHEAD EDUCATION COMMITTEE

BIRKENHEAD TECHNICAL COLLEGE

(Principal C V Vinten Fenton, M Sc, A M I E E, A M I Mech E)

Applications are invited for the following f time appointment, commencing as soon as p sible Senior Lecturer in Chemical Engineeri Applicants should possess university degree and corporate members of the Institution of Chem Engineers It is desirable that they should h had previous teaching and industrial experier This is a new department with ample scope development Salary £1,215 maximum Sala in accordance with Burnham Technical Scale

Further particulars and application forms f the undersigned, to whom completed applicat should be returned within fourteen days of appearance of this advertisement

H GLYN WILKINSON
Director of Educat
63 Hamilton Square, Birkenhead

UNIVERSITY OF SYDNEY

AUSTRALIA

The Senate will shortly proceed to an appo ment to the Chair of Anthropology Salary be at the rate of £A 2,500 per annum There normal retirement provision under the Professo Superannuation Scheme, and, in addition, a sion of not less than £A 400 per annum upon tirement after the age of sixty years Fina available for home purchase under the Members' Housing Scheme The Senate rese the right to fill the Chair by invitation

Further particulars and information as to method of application may be obtained from Secretary, Association of Universities of British Commonwealth, 5 Gordon Square, Lond W C 1 The closing date for the receipt of plications, in Australia and London, is May 1955

CENTRAL RESEARCH ESTABLISHME National Coal Board (at Isleworth, Middle invite applications for the undermentioned su annuable appointments Engineer or Physicist lead a group concerned with the design and velopment of mechanical and electro-mechan instruments required for mining research inclu certain aspects of health and safety Work be carried out initially in the laboratory, altho confirmation of the behaviour of equipment in conditions is an essential feature Good hon degree in mechanical engineering or physics, equivalent professional qualifications, and siderable experience in research and practice the instrument field is required Appointment be as Scientist Grade I (scale £1,150 by £4 £1,350, thence by range to £1,550, male), Lon location allowance of £82 minimum rising to maximum is payable in addition (Reference TT/940) Physicist to carry out research on detection and assessment The initial objec to devise and develop instruments and equip for giving a continuous record of methane centration and to operate alarms or switch power when a given limit is exceeded Ca dates should have a good honours degree physics or equivalent professional qualificat and preferably some experience in resea Appointment, according to qualifications and perience as Scientist Grade II (scale £858 £1,232 inclusive, male, and £750 to £1,070 in sive, female) or Scientist Grade III (scale £53 £1,016 inclusive, male, and £509 to £893 inclu female) (Reference No TT/941) —Write, gi full particulars (in chronological order) of education, qualifications and experience (dates) to National Coal Board, Establishm (Personnel), Hobart House, Grosvenor Pl London, S W 1 marking envelope with the vant TT Reference Number quoted ab Original testimonials should not be forwar Closing date April 16, 1955

BRITISH ELECTRICITY AUTHORI Headquarters, Bankside House, London, requ male or female Technical Assistant (statisticia the office of the Technical Engineer and Sta cian Candidates should possess an aptitude figures and should have a working knowledg algebra and the use of desk calculating mach The successful candidate will be required to n calculations for summaries and analysis of t nical data concerning the operation of p stations and to prepare material for technical ports, other duties will include the keepin records and the compilation of technical ret Salary within N J C Grade 2, £555 to inclusive —Applications, giving details of age, perience and present position and salary, sh be forwarded to D Moffat, Director of Estab ments Winsley Street, London, W 1, by M 18, 1955 Quote Ref AE/571

IUSEUM AND ART GALLERY

DONCASTER

'POINTMENT OF MUSEUM ASSISTANT

pplications are invited for the post of Museum
stant (male) at a salary in accordance with
de A P T II (£560 by £20 to £640 per annum,
a starting point up to £600 per annum) of
National conditions of service The appoint-
it is subject to the Local Government Super-
uation Acts, 1937-1953, and the passing of a
lical examination The duties will include
ral museum work and applicants must have
e experience of museum development and
ild have special interest and knowledge of
neology and bygones It is further essential
the applicant has experience in the mainten-
e and care of small animals in vivaria Ex-
ence of diorama modelling will also be con-
red an asset

pplications stating age experience and qualifi-
ons together with the names of three referees,
copies of three recent testimonials should be
mitted to The Director, Museum and Art
lery, Waterdale Doncaster not later than
rch 19 1955 Candidates must disclose in
ing whether to their knowledge they are re-
d to any member of, or holder of any senior
e of the Council

H R WORMALD,
Town Clerk

inty Borough of Doncaster

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

A E R E, HARWELL BERKS

equires Computors The work will provide
opportunity to learn a wide variety of com-
ational techniques, with the possibility of work-
with an electronic digital machine and
iched card machine installations Experience
computing work would be an advantage but is
essential Successful candidates will either be
ointed in the grade of Assistant Experimental
icer (£310 (at age 18) to £685 per annum
ile)), minimum qualifications of general certifi-
e of education "advanced" level in mathe-
tics and a science subject or equivalent qualifi-
ions or in the grade of Scientific Assistant
35 (at age 16) to £550 per annum (male))
nimum qualifications of general certificate of
ication "ordinary" level in four subjects, in-
ding English or mathematics or equivalent
lifications Rates for women are slightly
er Officers who are 18 years or over are re-
red to join the Authority's contributory super-
uation scheme

Applications which will be considered from
didates who will finish their education this
demic year (i e summer, 1955) should be
to Establishment Officer United Kingdom
mic Energy Authority A E R E, Harwell,
lcot Berks quoting 2/103/246

NIVERSITY OF SOUTHAMPTON

Applications are invited for the post of
earch Assistant in Ecology (second appoint-
nt) established under Nature Conservancy
nt for investigations into competition between
dominants in the Norfolk Broads Require
nts include a first- or good second-class degree
botany with ecological and physiological in-
sts The appointment is for three years, and
k for a higher degree is permitted Salary
5 per annum plus £75 per annum travelling
wance

urther particulars from the Secretary and
gistrar University of Southampton Closing
e March 26 1955

LECTRONICS ENGINEERS AND PHYSI-
s required for various posts in Research and
velopment Establishments of Ministry of
ply chiefly near Bournemouth Hants Mal-
n, Worcs Farnborough, Hants and London
) Applicants who have or expect to obtain
- or second class honours degree or equivalent
be considered for Scientific Officer class
ry within range £467 10s to £845 provincial
ndon rate £25 to £40 higher) Those with
er qualifications e g pass degree H N C,
al C and G cert etc, minimum higher school
ificate (science) may be considered for Ex-
imental Officer class Salary according to age
erience etc within range Experimental Officer
inimum age 26), £715 to £880, Assistant Ex-
imental Officer £288 10s (age 18) to £640
vincial (London rate £14 to £40 higher) Salary
s for women somewhat less F S S U bene-
may be available for Scientific Officer class
sibilities of promotion Not established but
ortunities to compete for establishment may
e—Application forms from Ministry of
bour and National Service Technical and
entific Register (K) 26 King Street London
W 1 quoting D 81/5A

UNIVERSITY OF SYDNEY

AUSTRALIA

Applications are invited for the position of Lecturer in Biochemistry The salary for a Lecturer is within the range of £A 1,100 to £A 1,450 per annum with annual increments of £A 50 The salary is subject to deductions under the State Superannuation Act The commencing salary will be fixed according to the qualifications and experience of the successful applicant Finance available for home purchase under Staff Members Housing Scheme

Further particulars and information as to the method of application may be obtained from the Secretary Association of Universities of the British Commonwealth, 5 Gordon Square London W C 1 The closing date for receipt of applications in London and Australia is April 9, 1955

ESSEX EDUCATION COMMITTEE

SOUTH-EAST ESSEX TECHNICAL COLLEGE

Longbridge Road, Dagenham

Applications are invited for three posts of Laboratory Steward (or Laboratory Technician) in the Physics Department Applicants should have passed the City and Guilds Intermediate examination for laboratory technicians or general certificate of education (ordinary) in physics, or have had suitable previous experience Salary (male or female) Under 21, £180 at 16 to £285 at 20 (including London weighting) Over 21 £375 by £15 to £485 plus London weighting (£20 to £30) (Commencing salary depending upon experience)

Form of application from the Clerk to the Governors at the College

---

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Assistant Lecturer or Lecturer in the Department of Zoology The initial salary for an Assistant Lecturer will be £550 per annum The initial salary for a Lecturer will be within the range £650 to £800 per annum according to qualifications and experience

Applications stating age experience and academic qualifications together with the names of three referees, should be received not later than April 2 1955 by the undersigned from whom further particulars of the conditions of appointment may be obtained

STANLEY DUMBELL
Registrar

APPLICATIONS ARE INVITED FOR superannuable appointments as Technical Translators in the Translation Section of National Coal Board's London Headquarters Candidates who must be able to write clear and concise English should have a thorough knowledge of at least two foreign languages one of which must be German and the other either Dutch, French Polish or Russian Experience in translating technical and scientific articles would be an advantage Salary, according to qualifications and experience, in a scale £555 by £20 to £695 (male), and £449 by £16 to £561 (female) plus London location allowance of £32 10s at the minimum rising to £42 per annum at the maximum of the scales—Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel) Hobart House, Grosvenor Place London, S W 1 marking envelope TT/939 Original testimonials should not be forwarded Closing date March 31, 1955

MECHANICAL ENGINEERS REQUIRED AT Research and Development Establishments of the Ministry of Supply near Sevenoaks Kent Chertsey, Surrey Farnborough Hants and Amesbury Wilts Applicants should have or be expecting to obtain a first- or second-class honours degree or equivalent, with aptitude for work concerned with research design and development of wide range of civil and military equipment Appointment initially in Scientific Officer grade Salary according to age and appropriate research or development experience within range £467 10s to £845 Women somewhat less Prospects of promotion Not established but opportunities to compete for establishment may arise • F S S U benefits may be available—Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street, London S W 1 quoting C 95/5A

UNIVERSITY OF LONDON KING S COLLEGE will require on October 1 1955, two Lecturers in Physiology one to replace a member of staff recently appointed to a chair The salary will be at a point on the scale £900 by £100 to £1 200 with family allowances and F S S U benefits—Particulars and application forms should be obtained from the Registrar King's College Strand W C 2 whom completed applications should reach by March 28 1955

UNIVERSITY OF NOTTINGHAM

THE SIR JESSE BOOT CHAIR OF ORGANIC CHEMISTRY

Applications are invited for election to the Sir Jesse Boot Chair of Organic Chemistry Salary £2 250 per annum with superannuation (Federated Superannuation System for Universities) and family allowance

Conditions of appointment may be obtained from the undersigned to whom completed applications should be sent if possible not later than April 13, 1955

H PICKBOURNE,
Registrar

UNIVERSITY OF ST ANDREWS

The University Court invites applications for the Chair of Geology in the University The Professor will be a member of the United College of St Salvator and St Leonard, St Andrews The salary attached to the Chair is £2 200 per annum plus F S S U and family allowances A grant towards removal expenses may be made

Applications (30 copies), including the names of three referees must be submitted by April 30 1955, to the undersigned, from whom further particulars may be obtained

D M DEVINE
Joint Clerk to the University Court

TECHNICIAN (FEMALE) PASSED INTERmediate examination in I M T with experience in histology required for work in electron microscopy N H S scale wages according to experience—Apply in writing to Director Research Department Royal Beatson Memorial Hospital 132 Hill Street, Glasgow

APPOINTMENTS VACANT

TECHNICAL LIBRARIAN

Courtaulds Limited requires a male Librarian/Information Officer in its Textile Research Laboratory Bocking, Essex Responsibilities include the administration of a medium-sized scientific and technical library, the editing of technical reports the preparation of literature surveys and the indexing of current publications Applicants with a scientific degree and some knowledge of textile science and technology preferred but a qualification in librarianship or experience in a specialist library is essential A knowledge of German is required Age 25/35 Salary in accordance with age and experience

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds Limited 16 St Martin's-le-Grand London E C 1 quoting the reference number D 65

TECHNICAL LIBRARIAN

WOMAN

Courtaulds Limited require a technical librarian (woman) for a new research laboratory at Coventry Candidates should have a knowledge of chemistry to degree standard and previous experience in an industrial technical library

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds Limited 16 St Martin s-le-Grand London E C 1 quoting the reference number D 60

IMPERIAL CHEMICAL INDUSTRIES Limited Billingham Division have a vacancy for an Assistant in the Intelligence Section of the Billingham Works to deal mainly with the abstracting and translating of scientific literature relative to the Division's interests Candidates men or women must have a pass B Sc degree as a minimum qualification and should have a good knowledge of German or Russian or both Some experience in technical translations would be an advantage The salary maximum for the post is £950 (men) or £760 (women) The starting salary will depend on qualifications and experience The post carries attractive conditions of service e g, staff pension fund profit-sharing scheme five-day week, etc—Write without commitment for application form, to the Staff Manager Imperial Chemical Industries Limited Billingham Division Billingham Co Durham quoting reference G 2

CHIEF CHEMIST OF LARGE FOOD Manufacturers in London area requires personal assistant Applicants should be male qualified chemists with considerable experience in the food industry aged preferably 30-40 Salary about £1 100 per annum Contributory pension scheme —Apply to Box 665 T G Scott and Son, Ltd 143-147 Regent Street London W 1

ALLEN & HANBURYS LTD WARE Herts require Assistant Chemists preferably of Inter science standard, for their Organic Research Laboratories Opportunity for further study is available Five-day week—Apply Personnel Manager

RESEARCH

Vacancies exist in the Research Department of SIMON-CARVES LTD for a number of alert young Research Officers The fields of interest include fluidisation, flame combustion, discharge in gases, electro-precipitation, behaviour of small particles, certain aspects of reaction kinetics and applied thermodynamics and computation of physico-chemical data Reliable Experimental Officers and Assistants are also required for work in these fields and in the analysis and testing of fuels, by-products, industrial dusts, refractories, soils, and materials of construction

RESEARCH OFFICERS

Good degree essential Initial salary in range of £600 to £900, depending on experience (Ref F P 100)

EXPERIMENTAL OFFICERS

Essential requirements either degree or H N C (or equivalent) and previous experience Non-graduates must be 26 or over to qualify Starting salary in range £500 to £650 (Ref F P 101)

EXPERIMENTAL ASSISTANTS

Good G C E or O N C required Age range 21 to 26 Initial salary between £390 and £475 (Ref F P 102)

JUNIOR EXPERIMENTAL ASSISTANTS

Candidates should have a good G C E (English, Maths and 2 science subjects) Age range 17 to 20 Salary according to age (Ref F P 103)

Working conditions are excellent, scope is good There is a pension scheme in operation Write, quoting the appropriate reference, to Staff and Training Division, Simon-Carves Ltd, Cheadle Heath, Stockport

---

PLANT PROTECTION LIMITED HAVE A vacancy for a female chemist with qualifications of degree standard to do general laboratory and abstracting work, knowledge of French and German useful —Applications to Technical Department, Plant Protection, Limited, Yalding, Kent, stating full particulars

---

JUNIOR ENGINEERS REQUIRED IN DEpartments covering the design and construction of high-grade television transmission equipment and a wide range of electronic equipment Good fundamental knowledge required and some practical commercial experience desirable Pension scheme Five-day week Good canteen —Write, stating age experience and salary required to Cinema-Television Limited Worsley Bridge Road, Lower Sydenham, S E 26

CHEMIST

HONOURS GRADUATE

Courtaulds, Ltd, has a vacancy in its Textile Research Laboratory at Bocking, Essex, for a Graduate Physical Chemist who is interested in the basic physical problems of textile chemistry and is prepared to contribute original ideas in a developing situation Applicants should possess an honours degree and have had practical experience of research methods Age 25 to 33

Candidates should write for a detailed form of application to the Director of Personnel Courtaulds, Ltd, 16 St Martin's-le-Grand, London, E C 1, quoting the reference number D 64

RESEARCH AND DEVELOPMENT CHEMists required by Johnson and Johnson (Gt Britain) Ltd, for their Laboratories near Portsmouth Candidates should hold a degree in chemistry and/or a qualification of the I R I Previous industrial experience in the rubber and resin fields is desirable, though not essential Commencing salary not less than £700 Excellent prospects —Apply to Research Director, Johnson and Johnson (Gt Britain) Ltd, Research Department, 240-242 Bath Road, Slough, Bucks

---

LEADING OIL COMPANY HAVE VACANCY for Chemist in their Head Office Applicants should be in possession of degree or equivalent and if possible wide experience in the petroleum industry Work to cover lubricants, solvents, bitumens, fuels, etc Age 30 to 35 years Salary according to age and qualifications —Applicants should apply, giving full particulars of qualifications and experience, quoting H 3115 to Box 7327, c/o 191 Gresham House, E C 2

RESEARCH ENGINEERS, PREFERABLY OF degree standard, and with a sound knowledge of communications and, particularly, electronics required for experimental work relating to underwater sound apparatus —Applications, giving past experience, technical qualifications, age and salary required, should be addressed to the Personnel Manager, Kelvin and Hughes Ltd, New North Road, Barkingside, Ilford, Essex

---

BRITISH INSULATED CALLENDER'S Cables Ltd, require Chemists at their Helsby works, near Chester, preferably graduates with some industrial experience, for development and analytical work on Thermoplastic Cable Compounds —Applications should be submitted in writing, quoting reference H/73/55, to the Staff Officer B I C C Ltd, Prescott, Lancs

---

IMPERIAL CHEMICAL INDUSTRIES Limited Billingham Division, has several interesting vacancies for Physicists The Division has an expanding research programme and requires physicists to carry out work on the development of physical methods and techniques and their application to chemical problems and analytical methods There is also a requirement for Physicists or Electrical Engineers who have made a broad study of instrument technology or who wish to take up work in the fields of instrument development and management Candidates should be not more than 35 years of age and hold an honours degree Starting salaries will depend upon qualifications and experience —Write, giving full details of age, qualifications and experience, to the Staff Manager, Imperial Chemical Industries Limited, Billingham Division, Billingham, Co Durham quoting reference F 9

JOSEPH LUCAS, LIMITED, HAVE AN INteresting vacancy in their research and development laboratories which would be suitable for a young graduate with honours degree in mathematics or physics The work is largely of a fundamental nature, and is concerned with acoustics and mechanical vibrations Previous industrial experience is not necessary —Please reply giving qualifications, age and any other relevant details to Personnel Manager, Joseph Lucas (Electrical) Ltd, Great King Street, Birmingham, quoting reference PM/D/59

GRADUATE CHEMIST OR ENGINEER REquired by Research Association to apply in members' factories results of research Position suitable young man recently qualified or some experience Good starting salary excellent prospects Pension scheme —Write particulars training experience to Director, British Launderers' Research Association The Laboratories Hill View Gardens Hendon N W 4

ENGINEER, WITH ELECTRICAL OR PHYsicist degree required for development work on testing equipment for telecommunication cables Permanent and pensionable position at salary commensurate with experience and qualifications —Please apply giving full particulars to Personnel Officer Southern United Telephone Cables, Ltd, Dagenham Dock, Essex

---

ENGINEERS AND PHYSICIST

with a degree or higher national certifica
are required for permanent posts in the

GUIDED WEAPONS DIVISIO

of

ENGLISH ELECTRIC COMPANY LIMITED AT LUTON

for work on analogue computors a simulators

In particular a SENIOR MAN is requir to supervise the design and construction a large general purpose computor, and the are JUNIOR POSTS connected with th project and others allied to it

Applicants should preferably have desi experience in analogue computing or relate fields such as servo-mechanisms and negati feedback systems

Applications to Dept C P S 336 Strand, W C 2, quoting Ref S A 50C

THE RESEARCH DEPARTMENT OF leading industrial organization situated in south requires two graduates to undertake the pansion of an important research project nected with the raw materials of the indu The work involved, which offers ample scope initiative and imagination, will appeal to or chemists and biochemists who are intereste fundamental research on natural products an applying the results of this research to the cultural and manufacturing practices of the dustry Applicants must have a first- or sec class honours degree and some postgraduate perience would be useful, although not esser The appointments will be to the regular staff will be pensionable with starting salaries accor to age and experience within the range £70 £1,100 —Applications, giving full particulars be treated in confidence Box No T Haddon's, Salisbury Square, Fleet Street, E

TWO RESEARCH CHEMISTS APPL tions are invited from male graduates or pote graduates for the following posts in the fruit industry (i) Organic Chemist, preferably wit search experience in synthetic work (experien the isolation of substances from natural so would be an advantage) for pure and applie search in the carbohydrate field (ii) Ph Chemist or Biochemist for pure and applie search on problems of extraction from na products (involving enzymology) and of em cation in fruit products The successful cants for both positions will be required to on their own initiative and will be responsib the head of a small research department S will depend upon age, qualifications, and e ence in the range £600 to £800 The res department is attached to the factory and is ated in the Forest of Dean, applicants s therefore be willing to reside in a small co town Neither post carries exemption National Service —Applications, giving full d of age, marital state, qualifications and exper should be sent to The Personnel Man H W Carter and Co Ltd, The Royal F Factory, Coleford, Glos

---

ASSISTANT LIBRARIAN (FEMALE) quired for abstracting Applicants must ha degree in chemistry, good reading knowled French and German desirable, experienc library work or abstracting would be desi but not essential Permanent post, hours 9 to 5 30 p m Monday to Friday —Apply in in writing, quoting reference No 77 to Pers Officer, May and Baker Ltd, Dagenham, Ess

---

GRADUATE CHEMIST, PHYSICIST Chemical Engineer required by Chemical E eering Department in large paper making converting organization in S E England, to out process, investigation work and fundam research in paper making operation —Appl writing to the Personnel Officer, Albert E and Co Ltd Aylesford Paper Mills, Lark near Maidstone Kent, quoting reference C

LADY CHEMIST, GRADUATE OR H required for analysis of electroplating and solutions —Apply, Electro-Chemical Engine Co, Ltd, 161 Queens Road, Weybridge Su

GLAXO LABORATORIES LTD

Glaxo Laboratories Ltd invite applica-ions from graduates in one of the biological ciences for two posts at their Stoke Poges Research Laboratories The work of one of the posts involves research into bio-chemical and immunological aspects of the preparation of virus vaccines and the other he tissue culture propagation of viruses Postgraduate experience is a necessity for both posts

Those interested should write to Personnel Manager, Glaxo Laboratories Ltd, Green-ord, Middlesex

EXTILE CAREERS BRITISH NYLON nners Limited have several vacancies for young luates who will be given extensive technologi- training enabling them to become specialists his expanding organization The ideal quali-ion is a university degree in physics, engin-ig or textiles and candidates must have a ral bias towards applied work The selected lidates will be put to work under the super-n of experts and training will include a ough grounding in the manufacturing of yarns fibres and later in their development and essing to meet changing market requirements n successful completion of this training it is ided to employ these graduates in responsible ions on either technical development or ex-nental work or in the field of technical ser-

There will also be openings on the com-ial side of the business in which specialized vledge can be applied to the development of end-uses for the company's products A stic salary will be paid during training and vacancies offer exceptional opportunities to who are willing to work hard with a specific ct and in a climate of technical stimulation progress—Letters should contain full details academic achievements and a frank statement ambitions and inclinations, these should be essed to the Personnel Manager British Nylon iners Limited, Pontypool, Mon, and will be ed in strict confidence Candidates invited for view will be given a very clear impression of hat is implied by this new type of career

'ANTED BRITISH HONOURS GRADU- between 25 and 35 with sound knowledge applied mathematics (physics and statistics helpful) to share management of staff en-d in mechanized technical and scientific cal-tions Prospect of succeeding to management urity, enthusiasm, energy, adaptability and too academic a viewpoint essential Salary to £1,000, according to qualifications, quali- ability and experience—Apply before April 1955, to Managing Director, Scientific Com-ig Service Ltd., 23 Bedford Square, London, 1

QUIRED FOR PERMANENT POSITIONS Research activities in U S A Several men ing or soon to receive Ph D degrees in physi- organic or inorganic chemistry University ing essential Further academic or research ience desirable Applicants should be aged 30, eligible to emigrate to U S A Salaries nensurate with age and experience and ac-ng to U S A scales—Apply in writing, stat-country of birth and qualifications to E I Pont de Nemours and Co, Bush House, ych, London, W C 2

RESEARCH AND DEVELOPMENT

Courtaulds, Ltd, invite applications for the following vacancies in their Research and Development Laboratories Bocking Braintree, Essex Graduate Textile Technologist, age 27-32, with industrial experience, to work on textile dyeing and finishing Ref No D 61 Graduate Textile Technologist, to work on Research and Development in the field of textile manufacture Ref No D 62 Graduate Chemist, age 33 or less, for work on textile sizing Ref No D 63

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Limited, 16 St Martin's-le-Grand, London, E C 1, quoting the appropriate reference number

ENGINEERS BRITISH NYLON SPINNERS Limited would be interested to receive applications from Engineers for several appointments which are to be filled in the near future The duties will be in applied experimental work and will be of exceptional interest to mechanical engineers who can make the most of opportunities for original thought and application Sound general experience n mechanical engineering is called for, with a bias towards experimental work, and one of the appointments requires a wide experience in instrumentation In every case a good university degree is a desirable qualification followed by an apprenticeship and at least three years' industrial experience Inquiries are invited now, whether or not candidates are immediately available, and the fullest information will be given to those asked for interview, such interviews carry no obligation, but will enable candidates to meet the company's Chief Engineer and his staff and to measure at first hand the technical interest and career prospects—Apply in writing to Personnel Manager Pontypool Mon

ALLEN & HANBURYS, LTD, WARE Herts, require Research Chemist, organic for Research Laboratories Candidates should have at least first- or second-class honours, or M Sc and should be under 30 Previous experience in organic synthesis desirable but not essential The position is permanent, progressive and superannuated Five-day week—Apply, Personnel Manager

GRADUATE CHEMIST, METALLURGIST or Chemical Engineer required to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel—Apply, Electro-Chemical Engineering Co, Ltd, 161 Queens Road, Weybridge, Surrey

THE RESEARCH LABORATORY OF THE British Thomson-Houston Co Ltd require a Graduate in Metallurgy or Physics to join an expanding group working on the strength of metals, with particular reference to high temperature properties—Apply, quoting reference HJ and stating age qualifications and experience to the Director of Research, The British Thomson-Houston Co, Ltd, Rugby

APPLICATIONS ARE INVITED FROM physicists with honours degrees or their equivalent, for posts in the research laboratory of the British Thomson-Houston Co Ltd. The work involves investigations of photo-conductive materials and devices, but previous experience in this field is not essential—Apply, quoting reference WNB, and stating age, qualifications and experience, to the Director of Research, The British Thomson-Houston Co, Ltd, Rugby

GRADUATE

required by the

NELSON RESEARCH LABORATORIES

Stafford,

who is fully conversant with Vacuum Techniques and preferably has some experience in the design and testing of electronic valves

This is a progressive position in new Laboratories set in pleasant surroundings

Please apply to Dept C P S, 336-7 Strand, W C 2, quoting Ref 308D

BRITISH NYLON SPINNERS LIMITED The Company's expanding activities will give rise to further appointments, during the next few months, covering a wide field of scientific endeavour Graduate scientists and textile technologists, whether available now or later, are invited to register their interest at this stage and where necessary exploratory interviews will be arranged involving no obligation The openings will cover a range of work including pure research, applied research, plant experimentation and the development of new manufacturing techniques up to full scale operation For men with suitable ability and inclinations there will be opportunities for specializing in the new advanced forms of technology arising with the advent of synthetic fibres and their textile applications Several of the appointments will be at a senior level and the company will welcome tentative inquiries from chemists, physicists and textile graduates, these will be treated in strict confidence, and should be addressed to the Personnel Manager, British Nylon Spinners Limited Pontypool, Mon

PHYSICIST OR METAL-PHYSICIST REquired for *X*-ray Laboratory (industrial radiography and crystallography) Scope for long-term research as well as technological applications Good university degree essential Candidates would be given encouragement to gain wide research experience and the seniority which this appointment is intended to carry—Applications to Personnel Dept, Hadfields Ltd, East Hecla Works Sheffield, 9

QUALIFIED YOUNG MALE CHEMIST, physically fit and having some knowledge of biology, required at Surbiton Laboratories of large Bakery Organization Duties will ultimately include visiting bakeries in all parts of United Kingdom Salary within range £550 to £675 per annum, depending on experience, but no previous industrial experience necessary Contributory pension scheme—Apply to Box 664, T G Scott and Son, Ltd, 143-147 Regent St, London W 1

T & H SMITH LTD HAVE A VACANCY in their works at Edinburgh for a qualified pharmacist or chemist, under 35 years of age, for interesting work in connection with the development and production of allergy preparations Superannuation scheme in force—Apply, giving full personal particulars to Works Director, T & H Smith Ltd Blandfield Chemical Works, Wheatfield Road, Edinburgh, 11

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE
FROM LIVER OR YEAST
and other SIGMA brand products are now available
Ask for list SIGMA 8
GEORGE T. GURR LTD.
136-138 NEW KINGS RD, LONDON, S W 6
The Microscopical Stain People

◀ ◀ ◀ ◀ **GRATICULES**
We are now using so many modern methods of processing scales, masks and other graticules on glass that we can find a solution to most glass engraving and printing problems.
PATON HAWKSLEY
ROCKHILL LABORATORIES, KEYNSHAM, SOMERSET
Offices· 389 Archway Rd, London, N.6. KEYNSHAM 2364

GLASSWORKERS' STRAIN-VIEWING POLARISCOPE
Full wave retardation analyser for 5800 A gives most sensitive colour indication of strain Field and sight aperture 1¼″ dia Dimensions 6½″ × 5¼″ × 5″ Price £11 16s. 6d.
As above but without colour analyser showing strains against black field Price £4 15s 0d.
Immediate Delivery
H. S. B. MEAKIN, LTD., 36, Victoria Street, S.W.1
SUPPLIERS OF POLAROID PLASTIC and GLASS **Tel.: Abbey 6713**

CHEMIST REQUIRED FOR RESEARCH work on inorganic chemicals and metal extraction Applicants should have B Sc or A R I C, and some research experience would be preferred Permanent appointment with pension and life assurance Apply, stating reference NC F15, and details of age, qualifications and experience to

Personnel Officer (Staff),
Magnesium Elektron Limited
P O Box No 6, Lumm's Lane,
Clifton Junction, Swinton,
near Manchester

IMPERIAL CHEMICAL INDUSTRIES Limited seeks to fill the following vacancies in research work (1) A young woman honours graduate who has specialized in Zoology or possibly Microscopic Botany The appointment will be concerned with Histopathological work in connection with Chemotherapeutic Research (2) A Bacteriologist with a veterinary qualification The appointment is concerned with research on the chemotherapy of animal diseases Previous research experience is essential and preference will be given to candidates between 30 and 35 years of age (3) Organic Chemists to conduct Chemotherapeutic Research Candidates should hold a Ph D degree or have had an equivalent research training and should be under 30 years of age (4) A Biochemist to conduct research in the field of chemotherapy Candidates should hold a Ph D degree or have had an equivalent research training and should be under 30 years of age The Company's Research Laboratories are at present situated in the North Manchester area but new laboratories are now in the course of erection in a rural area about twenty miles south of Manchester —Applications, with full particulars should be addressed to the Staff Manager, Imperial Chemical (Pharmaceuticals) Limited Fulshaw Hall, Wilmslow, Manchester

SENIOR PHYSICIST REQUIRED TO initiate a Nuclear Physics section in a well equipped research laboratory Location in Northamptonshire —Box 661 T G Scott and Son, Ltd 143-147 Regent Street, London, W 1

" Advertisers please note You must add " Apply Employment Exchange " unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

BAKELITE LIMITED HAVE A NUMBER of vacancies for Chemists in their Research and Development Department Up to five years industrial experience (not necessarily in the plastics industry) would be an advantage There are also vacancies for chemists who will graduate or who will complete their national service in the next six months The work of the department covers a wide range of polymers and plastic materials and, in addition to original work involves development in this country of products and processes originating in the United States Candidates for these positions should have first- or second-class honours degree or equivalent qualifications —Applications should be addressed to Research and Development Director, Bakelite Ltd, Redfern Road, Tyseley, Birmingham, 11, and should give full details of age, training, qualifications, and experience

WORKS CHEMIST REQUIRED WITH some Laboratory and Industrial experience preferably possessing degree or equivalent Salary according to age and experience, etc —Apply to Works Manager Hopkin and Williams Ltd, Uphall Road, Ilford, Essex

FOR SALE AND WANTED

LEITZ BINOCULAR/MONOCULAR MICROSCOPE Square mech stage, substage Abbé condenser, swingout iris diaphragm quadruple N P Objectives 3, 5 6L and 1/12 O I Fluorite N A 1 32 Eyepieces Huygens paired ×6, paired ×10, single step micrometer ×6, single blood counting graticule ×6 Buerker Buerker B C slide in bakelite box Dark ground condenser N A 1 20 in box to fit microscope Adams haemometer and some assorted pipettes Completely reconditioned by Leitz (London) Ltd, November 1954 and guaranteed by them, immaculate as new The lot £105 —'Phone PERivale 2455 or 6420 or write Box 663 T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

APPOINTMENTS WANTE

SKILLED SCIENTIFIC GLASSWORK
26 years research and administrative experi
seeks change —Box 662, T G Scott and
Ltd, 143-147 Regent Street, London, W 1

GRANTS & SCHOLARSHI

INSTITUTION OF ELECTRICA ENGINEERS

SCHOLARSHIPS

The Council of The Institution of Elect
Engineers will consider for award this year
Research Scholarships, one Graduate Scholars
and six Student Scholarships Research Sch
ships, Ferranti, value £500 per annum for
years Oliver Lodge, value £420 for one
may be extended I M E A, value £420 for
year, may be extended Swan Memorial, v
£120 for one year C P Sparks Fund, v
£100 for one year Graduate Scholarship,
full-time postgraduate study Duddell, v
£400 for one year (May be awarded as a Stu
Scholarship) Student Scholarships for stud
undergraduate level at a university or a tech
college Duddell, value £200 per annum for
years Arthur Fleming, value £120 per an
for four years (for a sandwich diploma cou
Salomons value £60 for one year David Hu
value £60 for one year Paul value £75
annum for four years Thorrowgood, value
for one year

The closing date for the receipt of applica
is May 2 1955, for Student Scholarships
June 1, 1955, for Graduate and Research Sch
ships Full particulars of the conditions of a
attached to each scholarship and nomination f
may be obtained on application to the Secre
The Institution of Electrical Engineers, S
Place, W C 2

MISCELLANEOUS

TYPING MSS ETC FULL KNOWLE
technical medical and scientific terminolog
Box 667 T G Scott and Son, Ltd, 143
Regent Street London, W 1

VACUUM EQUIPMENT

THE FIRST
OF A NEW RANGE

PIRANI GAUGE

MODEL P.2.

Range 0.5 mm –0 001 mm Hg

Having the following advantages:

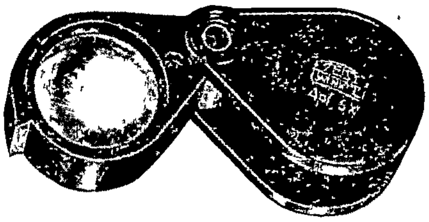
- MAINS OPERATION
- PROVISION FOR 2 HEADS
- BUILT-IN LEAK TESTING FACILITIES
- FULLY INTERCHANGEABLE GAUGE HEADS
- VERY ECONOMICAL FILAMENT REPLACEMENT SERVICE

V. W. THIRKELL

VACUUM EQUIPMENT

Elektron Works, 96a, Sydenham Road, London S.E.26. Telephone . SYD 4720

ZEISS
WINKEL



ZEISS LOUPES

These world-famous magnifiers which set the standard many years ago are now being manufactured in their Winkel factory They are achromatic and aplanatic, mounted in black folding plastic covers, and they are available singly in magnifications of 6×, 8×, and 10×, at £2 10s each, and in the double folding form 3× and 6× which used together give 9× at £4 7s 6d each

RAYNER

100 NEW BOND STREET, LONDON, W 1
Telephone GRO 5081

CATHODE RAY POLAROGRAPH

For Accurate and Speedy Analysis

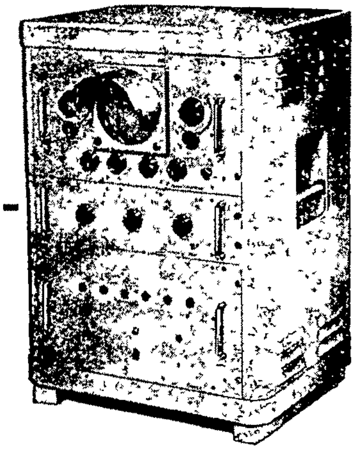
METALLURGICAL INORGANIC

ORGANIC

BIOCHEMICAL

QUALITATIVE

QUANTITATIVE



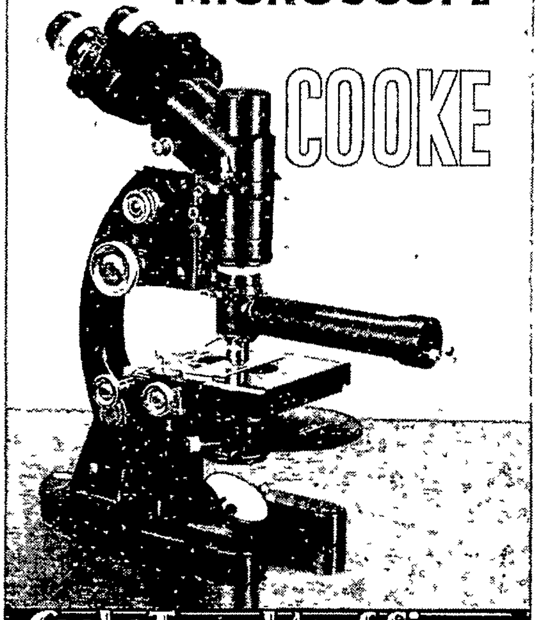
ROUTINE • SPECIAL RESEARCH

Write for leaflets

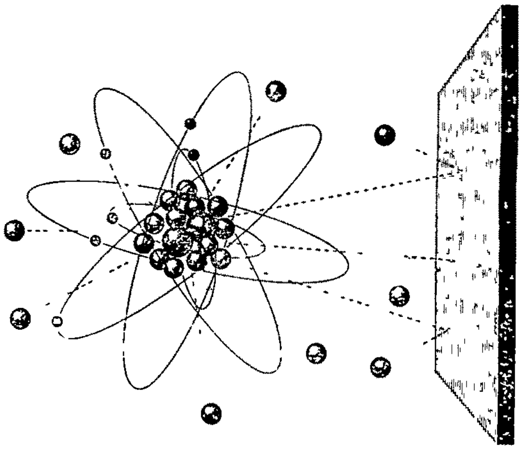
SOUTHERN INSTRUMENTS LTD.
Special Products Division
CAMBERLEY • SURREY *Phone Camberley* 2230

VARIABLE AMPLITUDE
PHASE CONTRAST
MICROSCOPE

COOKE



Cooke Troughton & Simms LTD
YORK ENGLAND

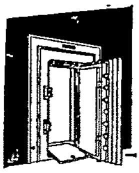


CHATWOOD'S

business is
Protection

ISOTOPE CONTAINERS • STIRRERS
GLOVE BOXES • VALVES
REMOTE CONTROL EQUIPMENT
SUPER-DENSE CONCRETE STRUCTURES
SHIELDED ROOMS, DOORS AND SAFES

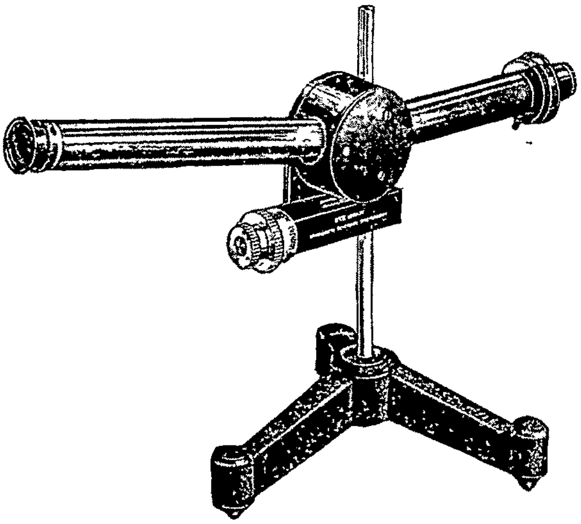
The Chatwood Safe and Engineering Co Ltd are able to offer specialised services to those responsible for guarding personnel against the hazards associated with nuclear reactions and radio-active elements. Chatwood have specialised in the development of protective structures and techniques for nearly one hundred years, and are qualified to help you with your problems.



R.P. DIVISION
THE CHATWOOD SAFE AND ENGINEERING COMPANY LIMITED
Shrewsbury Telephone Shrewsbury 4001

A NEW

REVERSION SPECTROSCOPE



This new model (No. 3505) is constructed on the reversion principle originated by Prof. H. Hartridge F.R.S. It enables readings to be made with ease and great accuracy.

Catalogue of Spectroscopes, post free from:—

R & J BECK LTD • 69 MORTIMER ST
LONDON W.1

Step by Step

Recently, interest has been revived in Step Micrometers, and consequently we have just redesigned our E 16 Eyepiece Micrometer

The scale is 10 mm long and is sub-divided into millimetres numbered 0–10 Each millimetre is further sub-divided into 10 divisions which are easily identified by a series of opaque steps The sharply defined image makes this well-balanced pattern a real asset in Microscopy Price 19s each, available from stock

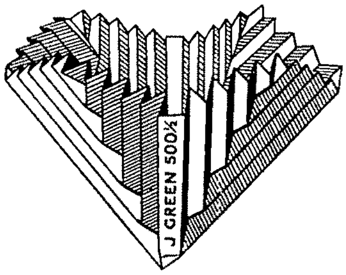
Complete List of Eyepiece and Stage Micrometers from

Graticules

LIMITED

57–60 HOLBORN VIADUCT, LONDON, E C

Phone CENtral 2717/8 Grams Rheinberg, Cent, Londo



GREEN'S PURE FILTER PAPER

This is the special fold for Agar Agar Green's No. 500½

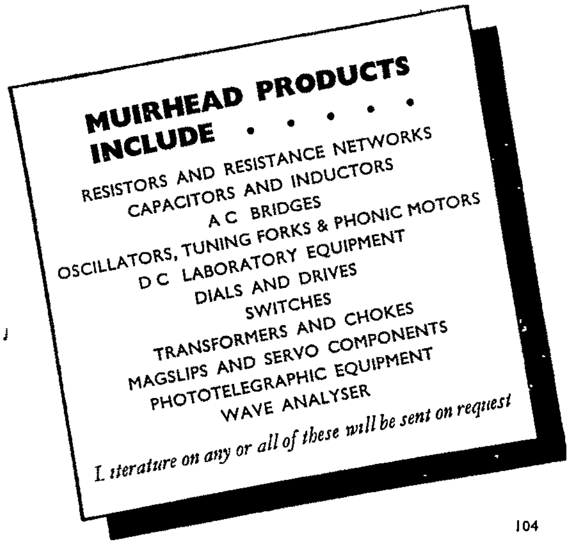
Write for price list NG

Makers:

J. BARCHAM GREEN LTD.

Maidstone • England

MUIRHEAD INSTRUMENTS for LEARNING AND EARNING



MUIRHEAD PRODUCTS INCLUDE . . . . . .

RESISTORS AND RESISTANCE NETWORKS
CAPACITORS AND INDUCTORS
A C BRIDGES
OSCILLATORS, TUNING FORKS & PHONIC MOTORS
D C LABORATORY EQUIPMENT
DIALS AND DRIVES
SWITCHES
TRANSFORMERS AND CHOKES
MAGSLIPS AND SERVO COMPONENTS
PHOTOTELEGRAPHIC EQUIPMENT
WAVE ANALYSER

Literature on any or all of these will be sent on request

104

MUIRHEAD & CO. LIMITED

PRECISION ELECTRICAL INSTRUMENT MAKERS

BECKENHAM · KENT · ENGLAND

Printed in Great Britain by FISHER, KNIGHT & Co, LTD, The Gainsborough Press, St Albans, and published by MACMILLAN & Co, LIMITED, at St Martin's Street, London, W C 2, and ST MARTIN'S PRESS, INC, 103 Park Avenue, New York 17, N Y, U S A —Saturday, March 12, 1955

NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye"—Wordsworth

Vol 175, No 4455 SATURDAY, MARCH 19, 1955 TWO SHILLINGS

PHYSICS LIBRARY 25

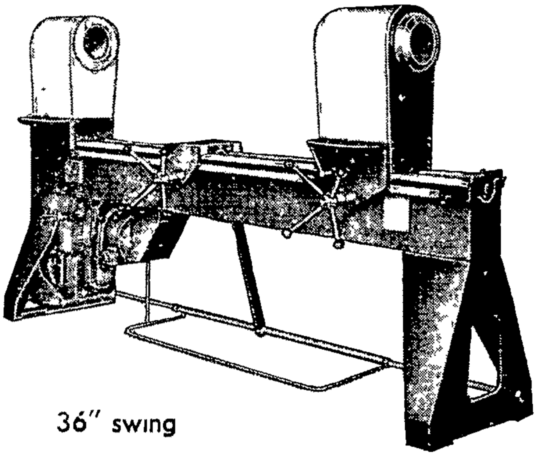
PHASE CONTRAST OUTFITS

- For excellent performance at modest cost
- Fit Baker or other microscopes made to accepted standards
- Available in powers × 10, × 40, × 100
- Outfits from £28 10s
- Complete instruments from £62 4s

C. Baker OF HOLBORN LTD. EST. 1765

METRON WORKS, PURLEY WAY
CROYDON, SURREY (CROydon 6644)
London Showrooms 244 High Holborn, W.C.1

HEAVY DUTY GLASS WORKING LATHE



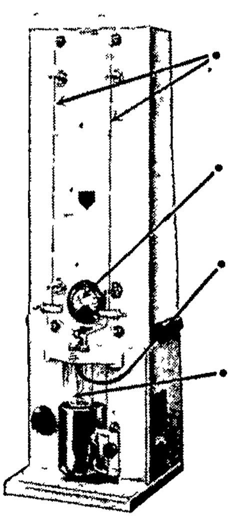
36″ swing

HEATHWAY MACHINERY CO. LTD.
UXBRIDGE ROAD, HILLINGDON, MIDDX.

B.T.L.
Electrometric Apparatus
for
KARL FISCHER TITRATIONS

Self-contained with a built-in end-point indicating circuit of high sensitivity, so that no external potentiometer is required

BAIRD & TATLOCK
(LONDON) LTD.
Scientific Instrument Makers
FRESHWATER RD, CHADWELL HEATH, ESSEX



Burette for Karl Fischer Reagent and Burette for methanol water solution for back titration

Micro-ammeter with scale marked "Excess Water" and "Excess Fischer"

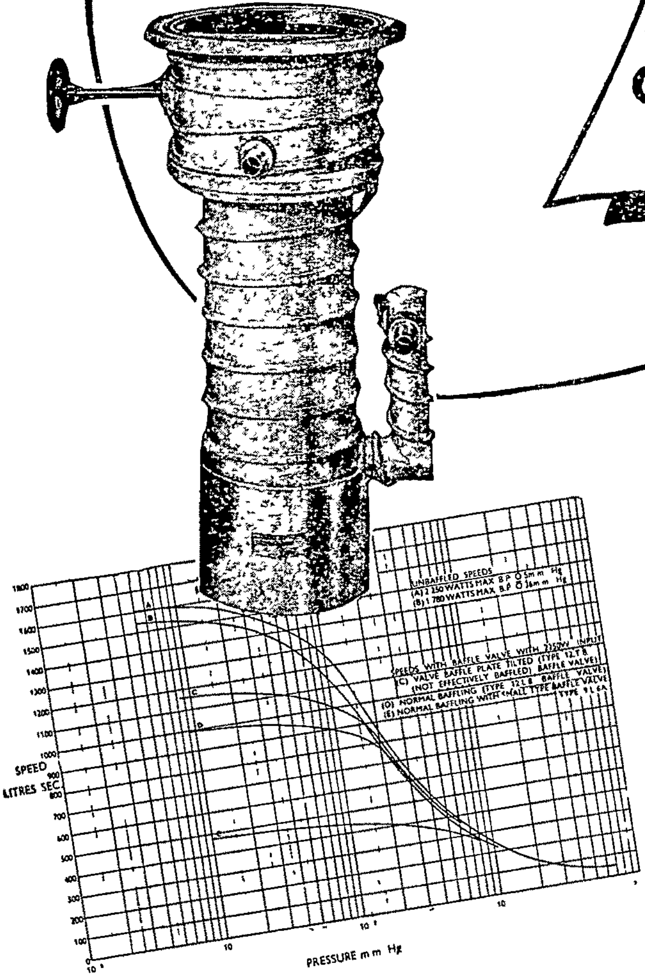
Nozzles and connections incorporated to enable dry nitrogen to be passed over contents of the reaction vessel

Three types of reaction vessel available, (a) standard as illustrated (b) with side tube for filling (c) with side tube for filling and base tube with stopcock for draining

1,500 LITRES EVERY SECOND!

–and without expensive backing lines

'SPEEDIVAC' 9" BOOSTER-STAGE OIL VAPOUR PUMP


UNBAFFLED SPEEDS
(A) 2 250 WATTS MAX B.P 0 5 mm Hg
(B) 1 780 WATTS MAX B.P 0 36 mm Hg
SPEEDS WITH BAFFLE VALVE WITH 2250W INPUT
(C) VALVE BAFFLE PLATE TILTED (TYPE 12 T B BAFFLE VALVE)
(NOT EFFECTIVELY BAFFLED)
(D) NORMAL BAFFLING (TYPE 12 L B BAFFLE VALVE)
(E) NORMAL BAFFLING WITH SMALL TYPE BAFFLE VALVE TYPE 9 L 6A
A
B
C
D
E
SPEED LITRES SEC
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
PRESSURE mm Hg
10
10
10
10

This vapour pump was specially designed to provide fast pumping speeds so essential to many large research installations and to meet the exacting requirements of commercial applications where rapid operation cycles are necessary without the need for large backing pumps and lines.

IMPORTANT FEATURES OF THE 903B VAPOUR PUMP

- ★ Integral "Booster-type" third stage permits high speeds against backing pressures as high as 0 5 mm Hg without large diameter backing lines or expensive backing pumps.
- ★ Combines high effective pumping speeds and backing pressure performance with less than normal heater inputs
- ★ Water-cooled baffle valve maintains highest practicable pumping speed with effective baffling and the operational advantages of an isolation valve

W. EDWARDS & CO (LONDON) LTD *for better vacuum service*

MANOR ROYAL · CRAWLEY · SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

A PORTABLE DRAUGHT GAUGE

Indispensable to all concerned with the measurement of flue draughts and small positive or negative pressures, this Draught Gauge has, in the inclined position, a range of 0 5 in. (12·5 mm.), and reads to 0 01 in (0 25 mm), while in the vertical its range is 3 4 in (84 mm). It is light and compact.

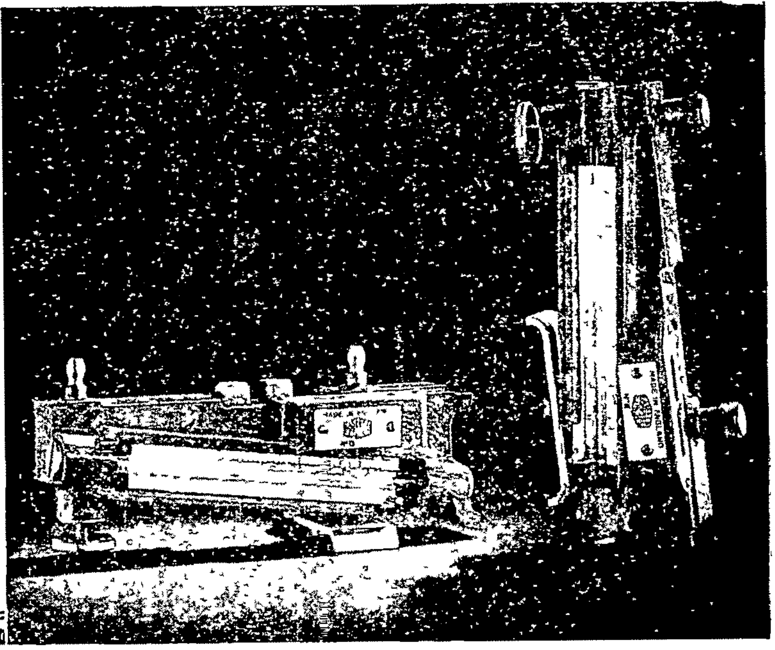
Size 7¼ × 3¼ × 1¾ in.
Weight 20 oz

Price £5 15s. 6d.

Available for immediate delivery —write for leaflet No. 764

C. F. CASELLA & Co. Ltd.
REGENT HOUSE
FITZROY SQUARE
LONDON, W.1
Telephone ★EUSton 3944

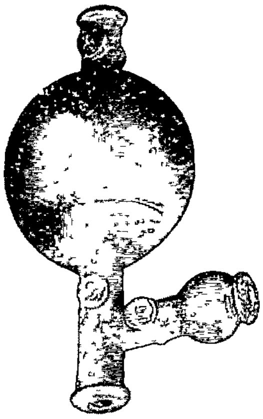
Member Scientific Instrument Manufacturers' Association of Great Britain



HOSLAB
Regd Trade Mark
Laboratory Equipment

PROPIPETTES
(Foreign)

For delivering liquids precisely and safely
pecially useful for corrosive, toxic and radio-active solutions

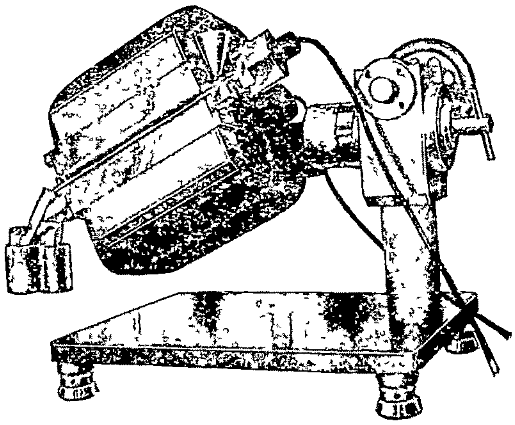


(LEAFLET ON APPLICATION)

OSPITAL AND LABORATORY SUPPLIES LTD.
12 CHARTERHOUSE SQUARE
LONDON, E.C.1
Telephones Clerkenwell 4840, 7941

OMPLETE LABORATORY FURNISHERS

MAGNETIC SEPARATOR



The Separator is essentially a powerful electro-magnet with pole pieces of special design, incorporating a feed hopper, a double-track non-magnetic pan with a vibrator, a divided chute and two collecting buckets

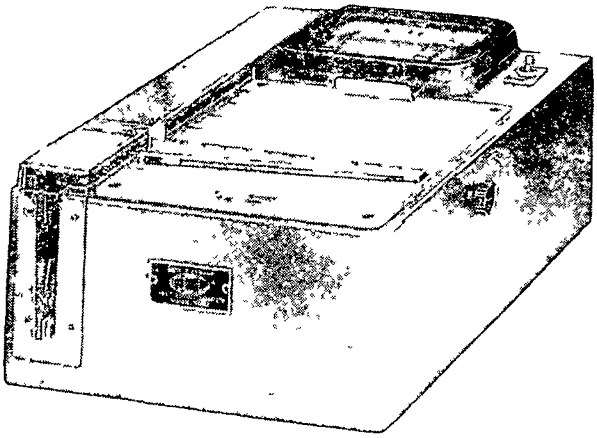
Please send for information and prices

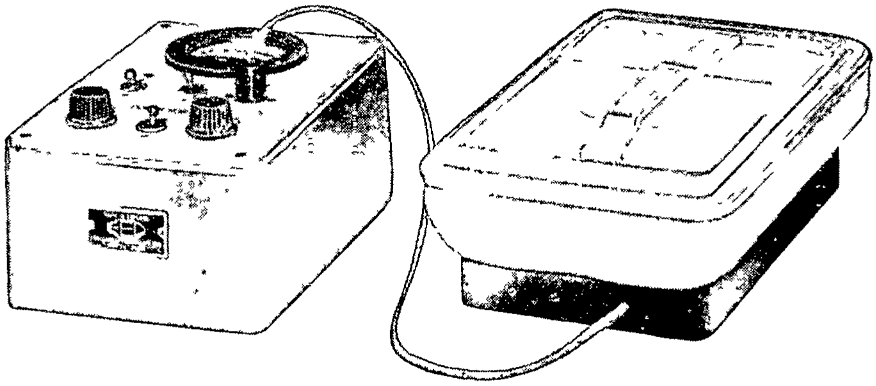
CHAS. W. COOK & SONS LTD.
97 Walsall Road, Perry Barr,
Birmingham, 22B, England

EEL

ELECTROPHORESIS APPARATUS

A complete apparatus for measurement of protein in body fluids, comprising Power Unit, Bath, and Photoelectric Measuring Unit





Simple to use
rapid, accurate
robust, and lo
priced

Full details readily available from

SELENIUM PHOTOCELLS
NEPHELOMETERS
PHOTOMETERS

EVANS ELECTROSELENIUM LTD

Sales Division 25, Harlow, Essex

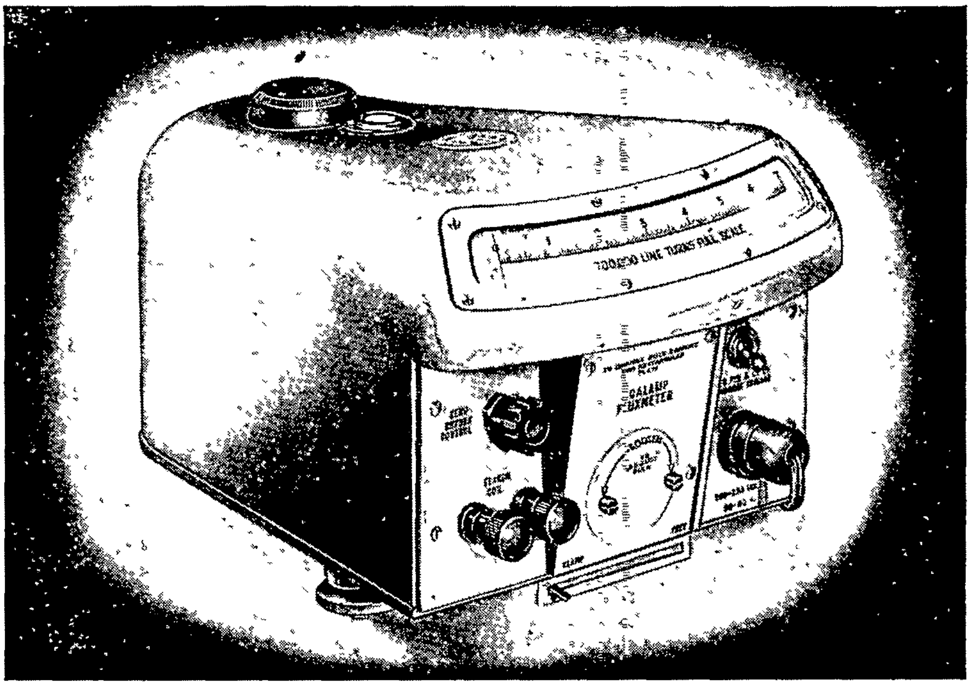
DENSITOMETERS
ABSORPTIOMETERS
SPECTROPHOTOMETERS
OPACIMETERS
FLAME PHOTOMETERS
COLORIMETERS
REFLECTOMETERS, ETC.

Representatives for Sales and Service

MANCHESTER AREA:
A. M Lock & Co , Ltd , Crompton Street, Chadderton, Lancs

NORTH OF ENGLAND
Electricals, Ltd , 14, Claremont Place, Newcastle-upon-Tyne, 2

SCOTLAND:
Atkins Robertson & Whiteford, Ltd., 92–100, Torrisdale Street, Glasgow, S 2



SCALAMP FLUXMETER

Excellent design and the selection of the most suitable materials are combined to give this new FLUXMETER a truly outstanding performance. The drift rate with a search coil of 10 ohms or less is 0·1 per cent. A two speed "return-to-zero" control is fitted enabling measurements to be made with rapidity and ease. A spirit level and levelling feet facilitate setting-up and the automatic and manual coil clamps safeguard the suspension in transit. The illumination of the lamp bulb is effected either by an external 4-volt battery or by mains supply through the built-in transformer. Two search coils of mean diameter 1 cm and of area turns of 10 or 100 cm.^{2} are available.

Please write for our descriptive leaflet quoting Cat. No NT 8834

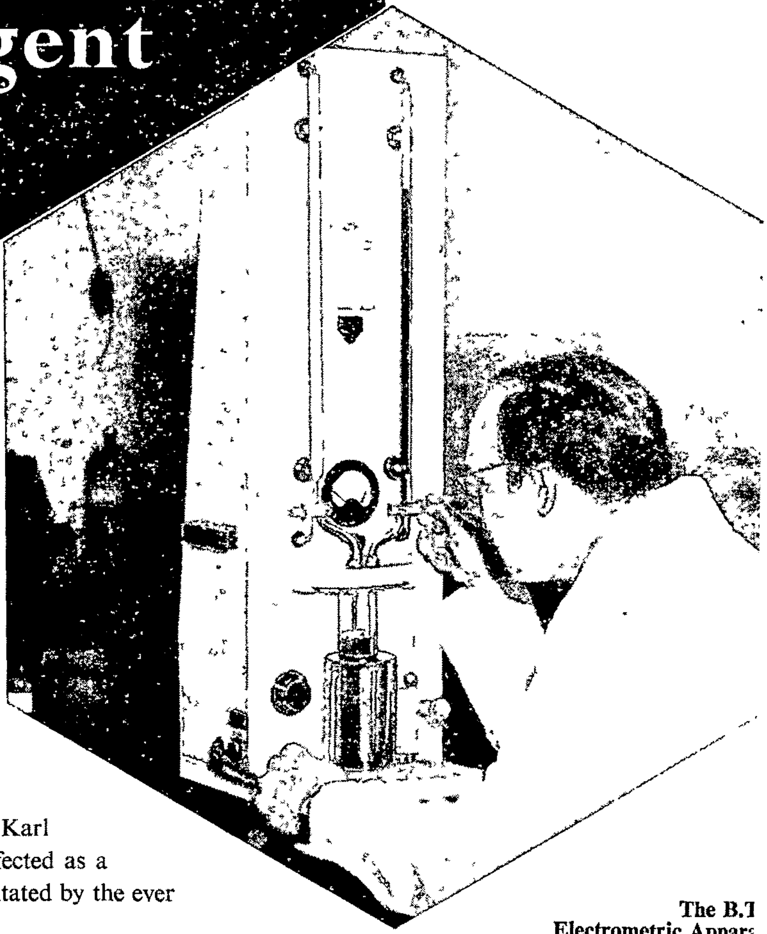
OUR NEW ILLUSTRATED CATALOGUE IS AVAILABLE ON REQUEST

SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO. LTD., GRANTA WORKS, CAMBRIDGE, ENGLAND

WG 55

Karl Fischer Reagent



The B.T
Electrometric Appar
for Karl Fisc
titrations, in us
the laboratorie
Hopkin & Williams I

NOW

REDUCED

IN

PRICE

Hopkin and Williams Ltd are pleased to announce the following substantially reduced prices for Karl Fischer Reagent which have been effected as a result of increased production necessitated by the ever growing demand for this reagent

H W CODE No 9350 5

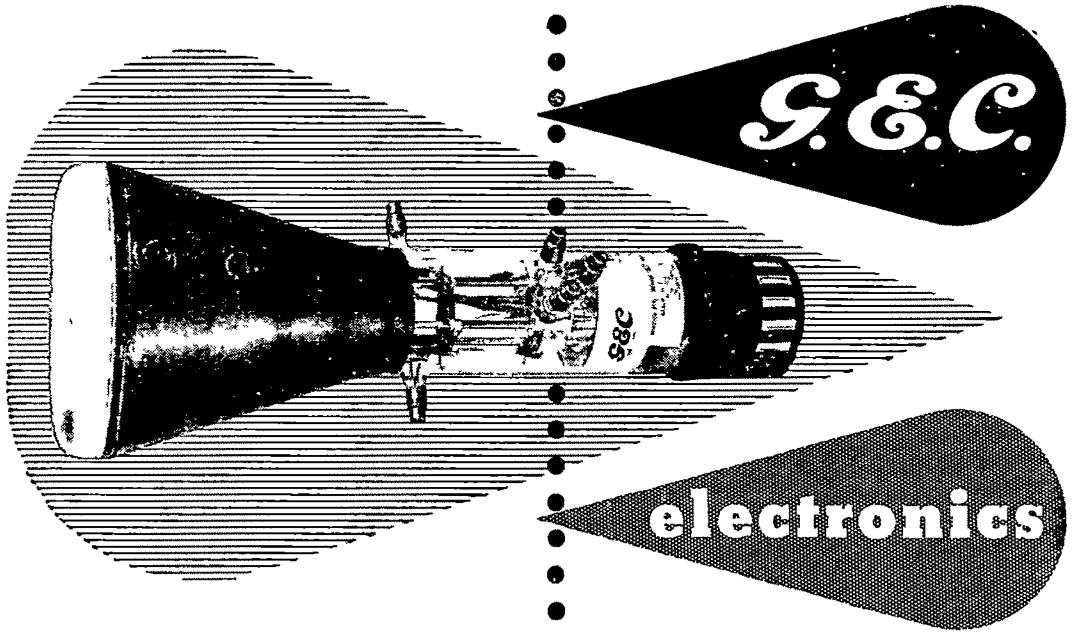
1000 ml 30/- 500 ml 16/-

The reagent is a single solution ready for immediate use and has a water equivalent of 5 mg of water per ml The price reduction amounts to approximately 25% but the quality of the reagent and its stability have been maintained at the usual high level

HOPKIN & WILLIAMS Limite

Manufacturers of pure chemicals for Research and Analysis

FRESHWATER ROAD CHADWELL HEATH, ESSE



Special purpose Cathode Ray Tubes
for Research and Industry

A range of cathode ray tubes is available for use in specialised applications such as the observation and recording of high speed transient phenomena, where the high capacitances and other limitations of the usual type of instrument tube would result in distortion or complete suppression of the trace

Typical applications of these special tubes include high voltage cable testing insulator overload and breakdown testing, cable fault finding by quasi-radar technique and the investigation of high voltage switching phenomena.

They are also suitable for use in laboratory oscilloscopes

Brief details of some of the more popular types are given below The tubes are of the all-electrostatic type, with heater ratings of 4V, 1 0A (approx)

401 CAHA
408 CAHA
Rating
Va3 (max) 1 5kV
Vp d a 3 3 5kV
Sx (av) 0 090mm/V
Sy (av) 0 100mm/V
Screen 401 CAHA Green-visual
408 CAHA Killed blue—photographic
Base B9G (pressed glass)

4cm dia high vacuum monitor tubes with one stage of post deflection acceleration For use in laboratory oscilloscopes, multi-channel strain-gauge recording equipment, etc.

908 BCC
Rating
Va3 (max) 10kV
Sx (av) 400/Va3 mm/V
Sy (av) 750/Va3 mm/V
Screen Killed blue—photographic
Base: B12D

A 9cm dia flat screen high speed recording tube with a low capacitance deflecting system The connections to the plates and final anode are brought out through side-arms Writing speeds of the order of 30,000 km/sec are possible, and transients of the order of 10^{-9} sec may be recorded

908 CARA
Va3 4kV
Vp d a 8kV
Sx (av) 0 085 mm/V
Sy (av) 0 12 mm/V
Screen Killed blue—photographic
Base B12D

A 9 cm dia flat screen high speed recording tube with one stage of post deflection acceleration For use where the special features of the 908 BCC cannot be employed to full advantage The Y plate connections and final anode are brought out through side arms

1601 ABC
Va3 (max) 5kV
Sx 660/Va3 mm/V
Sy 1100/Va3 mm/V
Screen Green—visual
Base B12D

A 16cm dia flat screen high speed oscillograph tube The construction is of the low capacitance type with the deflector plates and final anode connections brought out through side arms

1608 BCCA
Va3 (max) 3 5kV
Vp d a 3 (max) 10kV
Sx (av) 0 15mm/V
Sy (av) 0 27mm/V
Screen Killed blue—photographic
Base B12D

A 16cm dia flat screen tube of similar low capacitance construction as the 908 BCC, but with three stages of post deflection acceleration This tube will achieve similar writing speeds and recording periods as the 908 BCC, and is recommended for use where the deflecting potentials available are limited

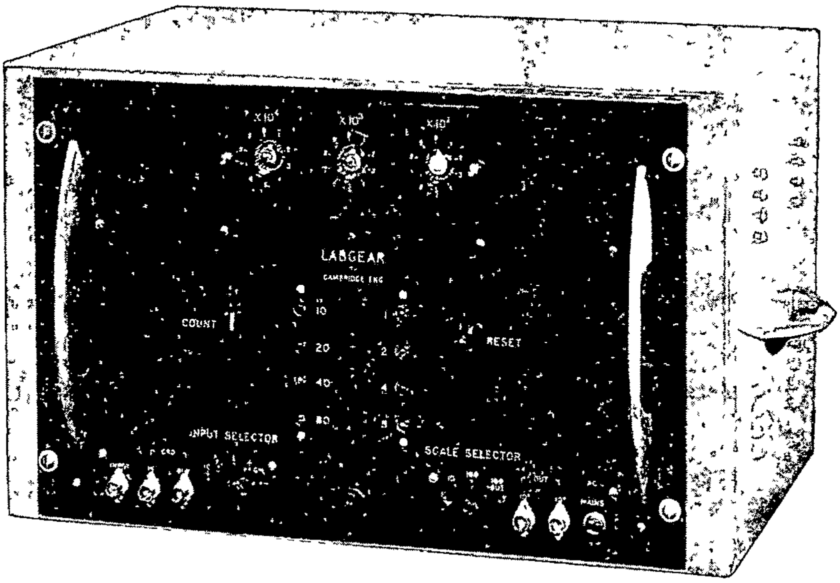
Alternative screens are available including long after-glow and white and blue aluminised types

Other types of special tubes are available including
Double gun tubes Storage tubes
Television monitor tubes
Conical deflection systems tubes for radial time bases Monoscopes, etc

Write to Osram Valve and Electronics Dept for full technical details
THE GENERAL ELECTRIC COMPANY LTD , MAGNET HOUSE, KINGSWAY, LONDON, W C 2

FAST SCALING UNIT

CATALOGUE No. D.4100



A five decade scaling unit of improved design particularly suited to use with scintillation and proportional counters

Price £148 in U.K. Delivery from stock

Features:

- Fully electronic scale of 100,000, or 100,000,000 with external Dekatron Register D 4019/V
- Zero reset of entire recorded count
- 10^2, 10^3, 10^4 and 10^5 count pulse for use in conjunction with Dekatron Automatic Timer D 4102 in " time-per-unit-events " applications
- Maximum steady counting rate 200,000 pulses/sec
- Power outlet for pre-amplifiers.
- Calibrated discrimination and paralysis time

Please write for detailed specifications of these and other Labgear Nucleonic Instruments and ancillary equipment.

Labgear (Cambridge) Ltd.

WILLOW PLACE
CAMBRIDGE

Telephone
Cambridge 2494/5

Telegrams
" Labgear Cambridge"

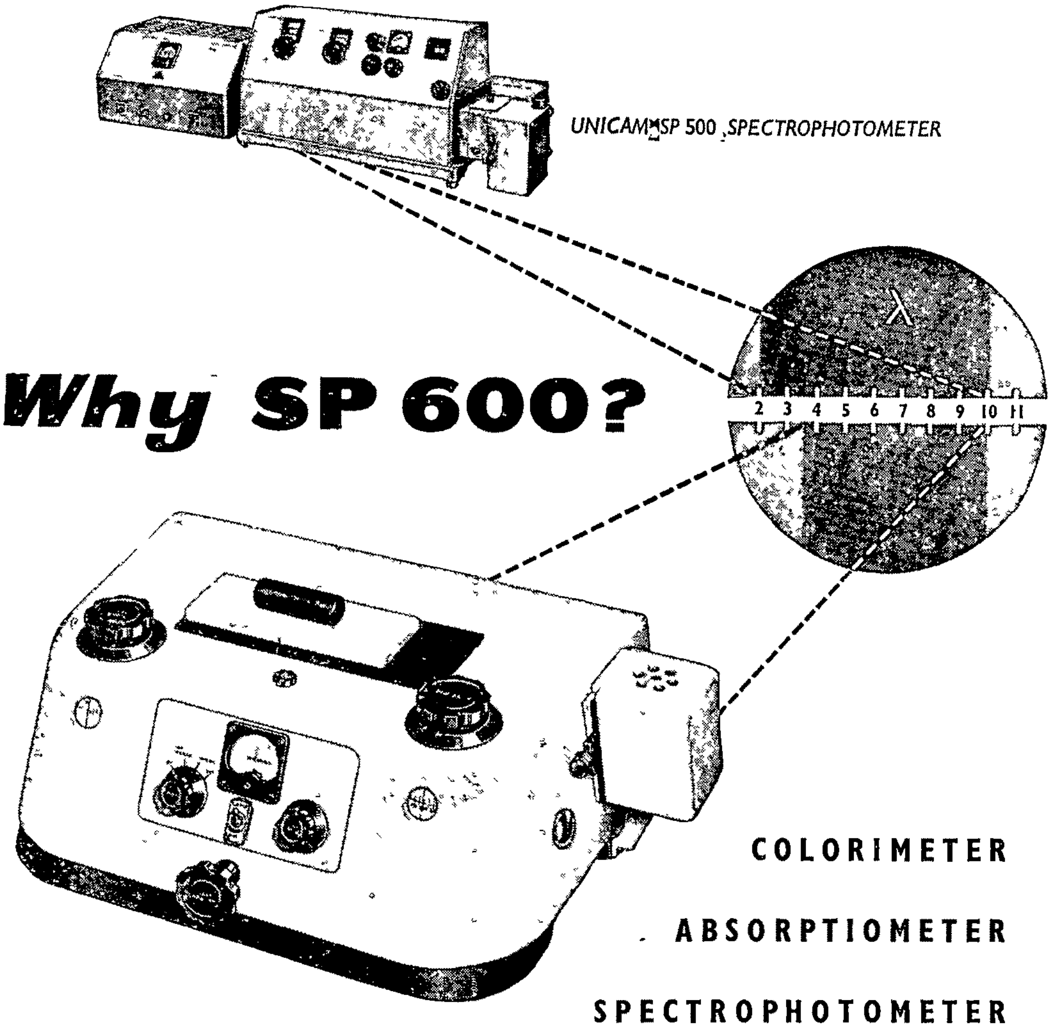
In the interest of *accuracy*

In the field of scientific photography, where performance must be capable of prediction and control within close limits, the consistently high quality of Ilford products has more than usual significance This accounts for the regular use of Ilford sensitised materials by scientific and industrial research organizations, both great and small, in every part of the world

ILFORD **PHOTOGRAPHIC MATERIALS**
in the Service of Science

ILFORD LIMITED ILFORD LONDON

Why SP 600?



COLORIMETER

ABSORPTIOMETER

SPECTROPHOTOMETER

In every way the SP 600 Spectrophotometer makes an ideal complement to the familiar SP 500 There are analytical problems (in the field of metallurgy, for example) which demand an instrument capable of precise absorption measurement at carefully selected wavelengths, but for which ultraviolet equipment is not necessary The SP 600 is designed to provide exactly these facilities

The dispersion of the glass prism and the high quality optical system give a resolution unobtainable with filters and the electronic detector-amplifier makes the instrument exceptionally sensitive. It is robust, easily operated and moderately priced.

Arrangements can be made for a comprehensive test in your own laboratory, without obligation. Please write for details.

BRITISH INSTRUMENT INDUSTRIES EXHIBITION
EARLS COURT LONDON
June 21 - July 9 1955
Stand No 4, Block F

UNICAM

SPECTROPHOTOMETERS

UNICAM INSTRUMENTS LTD • ARBURY WORKS • CAMBRIDGE

U'44B

NATURE

No 4455 SATURDAY, MARCH 19, 1955 Vol 175

CONTENTS

Page
Man-power for Colonial Development 481

War-time Radiobiological Research By Dr G. Pontecorvo 483
Applied Statistics By F Downton 484
Automatic Digital Calculating Machines. By Prof. A C. Aitken, F.R S 484
Enzymes, Genes, Viruses and Bacteria By M R Pollock 485

Colonial Research in the British Commonwealth 486
Mechanism of Intestinal Absorption of Fat. By Prof A C. Frazer 491

Obituaries
- Dr. R C Wallace By Prof J K Robertson 493
- Mr G. W Grabham, O B E By Dr K S Sandford 494
- Dr W. M Ware By Dr. H H Glasscock 494

News and Views 495

Birkenhead Technical College 498
Aslib Scottish Branch . Annual Meeting By Mrs Margaret Spence 499
Linen Industry Research Association 500
Apparent Heterogeneity of Deoxyribonucleic Acid Sedimentation Experiments at Low Concentrations By Dr K V Shooter and Prof J A V Butler 500
Distribution of Radio Brightness across the Andromeda Nebula. By Prof. John D Kraus 502

Letters to the Editors :
- Lung Injury by Impact with a Water Surface.—Group Captain W K. Stewart, K. E. Spells and Flight-Lieutenant J A Armstrong 504
- Crystalline-like Patterns in the Nuclei of Cells infected with an Animal Virus.—Lars Kjellén, Gosta Lagermalm, Dr. Arne Svedmyr and Karl-Gustaf Thorsson 505
- Effect of Injections of Œstrogen on the Mast Cells of the White Mouse —Dr Lucie Arvy 506
- Effect of Growth Hormone on the Large-Particle Content of Rat Liver —A. L. Greenbaum, T. F. Slater and Dr E. Reid 506
- The Hypothesis of Chromosomal Interference —Ernest E Shult and Prof. Carl C Lindegren 507
- Crystalline Trypsin Inhibitors from the Indian Field Bean and the Double Bean —Prof Kamala Sohonie and K. S. Ambe 508
- An Effect of Certain Proteins and Amines on Prostatic Acid Phosphatase —Grace M Jeffree 509
- Detection of Vascular Tissues available for Water Transport in the Hop by Colourless Derivatives of Basic Dyes —Dr P W. Talboys 510
- Role of Sulphydryl Groups in the Long-range Elasticity of Wool —R W Burley 510
- Molecular-sieving Properties of Starch —Borje Lindqvist and Torsten Storgards 511
- Ion-Exchange Separations on Chemically Modified Cellulose —N F Kember and R A Wells 512
- A Chromatographic Separation of *Meta*- and *Para*-Cresols —D White and D W Grant 513
- Potassium Permanganate in the Kjeldahl Method for the Determination of Nitrogen in Organic Substances —Dr. A E Beet 513
- Solubility of Silica —Dr P F. Holt and D T King 514
- Rheological Properties of Coal during Carbonization —D Fitzgerald 515
- Conductivity induced in Unplasticized 'Perspex' by X-rays —J F Fowler and Dr. F. T Farmer 516
- A Semi-annual Periodicity in the Beginnings of Recurrent Magnetic Storm Series —Dr. J H Rush 517
- Magnetic Structure of Manganese Arsenide —Dr G E Bacon and Dr. R. Street 518
- An Amplifier based on the Hall Effect —I M Ross and N. A C Thompson 518

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

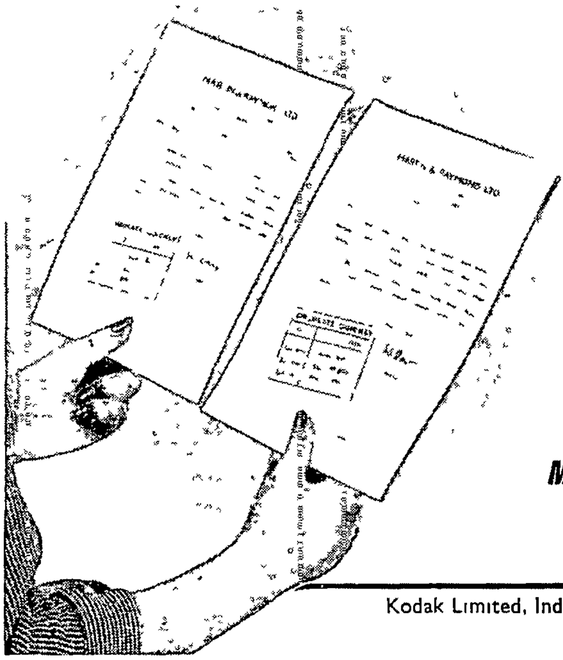
Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd , Crown House, 143-147 Regent Street, London, W.1
Telephone Number : Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

Cut copying time

with this 'one-step' paper



You copy documents with greater speed when you use Kodak 'Autopositive' Paper, because it gives you black-on-white photo-copies in one step, without intermediate negatives.

'Autopositive' paper's low-speed emulsion enables it to be processed in ordinary office lighting or indirect daylight. It has the high contrast and the "whiter white" base that are features of most 'Kodak' document-copying papers. You can make clear copies every time —even when the originals are faded

Kodak

MATERIALS FOR DOCUMENT COPYING

Please write (mentioning 'Nature') for the booklet "Document Copying Papers" and a free wallet of specimen prints

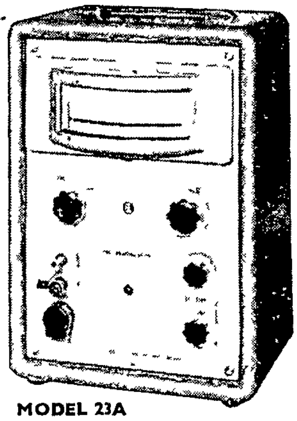
Kodak Limited, Industrial Sales Division, Kodak House, Kingsway, London, W C

'Kodak' and 'Autopositive' are trade-marks

Instruments for Research and Industry

Direct Reading pH Meter

A robust and exceptionally stable mains-driven instrument which is being widely used by leading firms, both at home and abroad The 6-inch mirror scale meter may be read to 0.05 pH, and the normal zero stability of the instrument is ± 0.02 pH. There are two pH scales: one reading 0–14 pH and the other giving a coverage of 7 pH over any part of the scale. A millivolt scale is also included and automatic temperature compensation is provided from 0° to 60° C.
A complete range of laboratory and industrial electrode systems is available for use with this instrument.



MODEL 23A

ELECTRONIC INSTRUMENTS LIMITED

RICHMOND : SURREY : ENGLAND

E·I·L

MAN-POWER FOR COLONIAL DEVELOPMENT

THE Queen's speech at the opening of the new session of Parliament on November 30 indicated he Government's intention to prolong the Colonial evelopment and Welfare Acts and to increase the nds available under them, as well as its continued pport of the Colombo Plan The debate on the peech in the House of Commons on December 3 ntred on Colonial development, and Mr. A. Lennox-oyd, Secretary of State for the Colonies, said that e hoped to introduce a further Colonial Development nd Welfare Bill at an early date which would provide additional sums for that purpose for 1955–60 e could not give any figures, as the Bill was not in nal form, but there would be an overlap of a year etween the money voted by the last Act and that hich would be provided under the new Bill The olonies have already been asked to draw up their lans for 1955–60, indicating their priorities and the xtent to which priorities can be met out of their wn resources.

Mr. Lennox-Boyd pointed out that expenditure on olonial development has been rising steadily and now running at the rate of about £110 million a ear Excluding some major projects and the work the statutory corporations and other public bodies, out £500 million is now involved in Colonial delopment, of which about half is coming from the cal resources of the territories, about one-third from ternal loans, and one-sixth, or about £14 million year, currently, from the Colonial Development and elfare Fund. Some 43 per cent of the latter monies spent on social services, 10 per cent on research, 6 per cent on surveys and censuses, nearly 20 per nt on economic purposes (mainly agriculture), and 5 per cent on communications.

Reviewing this expenditure, Mr. Lennox-Boyd rticularized the expenditure of £14 5 million on blic health and referred to the shortage of medical en and nurses in many parts of the world Of the 3 million expended on education, between £7 and million has gone on university education and about 8 million on technical and vocational training, and r Lennox-Boyd welcomed the plea which Mr. mes Griffiths had made for a greater development technical education. The more we can do to courage technical education, he said, the better shall serve the interests of the Colonial territories enabling them to live a full and complete life d meet on more even terms the problems of the odern world. He also welcomed the dramatic exnsion in university facilities since the Second orld War and, referring to the importance of the velopment of housing and water supplies, paid a rm tribute to an imaginative experiment initiated Sir Edward Twining among the Mahoude in nganyika. He promised to look into a suggestion ade by Mr Griffiths in regard to the relationship tween the Colonial Development Corporation and lonial Development and Welfare Funds, and he also emphasized the importance of encouraging the development of craftsmanship.

Replying for the Government on this debate, the Under-Secretary of State for Commonwealth Relations, Mr. D Dodds-Parker, dealt more particularly with the Colombo Plan, to which over six years Great Britain will be contributing about £300 million, of which £252 million represents the release of sterling balances. To India, Pakistan and Ceylon, these releases will amount to about £42 million a year, including £5 million for steel expansion in India and the same amount for the Sui Gas Transmission Company in Pakistan, while grants and loans to Malaya and North Borneo last year amounted to about £12 5 million By June 1954 the United Kingdom had agreed to supply about £840,000 for equipment for research institutions, laboratories, and railway training, while under the Colombo Plan Technical Co-operation Plan alone it had found 621 training places by June 1954 and had offered the services of 155 experts, of whom 111 were accepted.

Mr Dodds-Parker estimates that altogether Great Britain is spending about £200 million a year on overseas aid. This includes £1 33 million in support of the Specialized Agencies, £650,000 on the Technical Assistance Programme of the United Nations (to be increased to £800,000 this year), £18 5 million on Colonial development and welfare, £5 5 million on the Colonial Development Corporation, £23 5 million on Colonial loans as well as £10 million each to the Governments of Southern Rhodesia and New Zealand, £10 million to Pakistan in export credits and £400,000 for technical aid under the Colombo Plan. The Capital Issues Committee authorized private capital issues of £40 million while, through the World Bank, we released to India and Pakistan, in 1954, £10 million out of the £60 million for Commonwealth development spread over six years, and £42 million was released from sterling balances. The stress laid by Sir Arthur Braithwaite on the necessity for capital investment and the importance of providing adequate incentives was welcomed by Mr. Dodds-Parker He said that the Government is doing its utmost to see that priorities are put in the right order. He stressed also the general shortage of qualified and experienced technical and scientific personnel, and both he and Mr Lennox-Boyd emphasized the importance of the Colonial Territories themselves making the maximum use of their own resources in financing development. The Colonial governments have recently been informed of the Home Government's agreement in principle, and, subject to a review of the individual circumstances of each territory, to a small part of their currency funds, amounting to £365 million, held in London in the form of investments in United Kingdom issued securities, including some Colonial stock, being transferred into locally issued securities.

One point which was made by Sir Arthur Braithwaite and which, in slightly different form, was stressed by Mr. Dodds-Parker, puts in its proper perspective the value of the welfare work among overseas students of the British Council Sir Arthur, in connexion with civil engineering constructional work, stressed the value of bringing people from the Colonies to Great Britain for industrial, as well as academic, training Mr. Dodds-Parker pointed out that many students come to Britain at their own expense. He was impressed, in his recent visit to Asia, with the number of people who wished to send their children to Britain for higher education, and he thought that this is a continuing contribution which Britain can make.

There are now more than 8,000 Colonial students in Britain, some 3,500 of whom arrived during 1953. Nearly half of them are West Africans, but practically every Colonial territory is represented These figures alone emphasize the importance of the work of the British Council among overseas students, which, since 1949, has been met mainly from Colonial Development and Welfare Funds, with contributions from both the Foreign Office and the Commonwealth Relations Office also, since under the scheme initiated on January 1, 1950, the British Council is responsible for extending the welfare facilities for overseas students generally, as well as for maintaining hostels and other services for the welfare of Colonial students. Overseas students in the United Kingdom are now estimated to number about 25,000 compared with 10,000 in 1948, and although of the 3,647 students met by the British Council on arrival during 1953, 3,258 came from British Colonial territories and only 248 from foreign countries, accommodation of some kind at one time or another was found for 2,270 students from foreign countries during the year.

The latest report from the British Council*, which attributes the rapid increase in the number of overseas students to the increase in grants for study in British universities and technical colleges, and also to new schemes for training artisans in British industry and commerce arising directly out of Colonial development, reviews at some length the working of this scheme during the past four years, and the measure of its success in achieving its objectives. During that period, the Council's staff have met on arrival nearly 12,000 overseas students, more than 10,000 from Colonial territories, and confidence is expressed that the procedure devised for the purpose, in consultation with the Colonial Office and with the co-operation of the Customs and Immigration Authorities, has worked well and that a Colonial student is now helped through the inevitable formalities with sympathy and efficiency. It would, however, be of advantage if these reception arrangements could be expanded to meet the needs of other students from within and without the Commonwealth.

Most overseas students, on first arrival, go to London, where temporary lodging on arrival was found last year for some 6,500 students, nearly 5,500 from the Colonies. In 1953 a new hostel was opened in Lancaster Gate, London, primarily to meet this need, and it has now been recognized by the Colonial Office that such a transit hostel will be essential for som
time to come. It soon became obvious that hostel
for Colonial students were essential so long as th
number continued to increase, with segregation i
an undesirable type of boarding house as the onl
alternative. Accordingly, the policy of reducing th
number of hostel beds envisaged in the 1948 dis
cussions was abandoned. the Newcastle an
Edinburgh hostels were reprieved and improve
or extended, an enlarged and improved hostel fo
women students opened in London, while that a
Lancaster Gate also provides some permanent bed

Besides this hostel policy, which has also mad
Hans Crescent the centre for Colonial studen
activity in London, the Council has found permanen
accommodation in private lodgings for more tha
7,000 students, some 3,700 of them from the Colonie
Nearly 6,500 students have attended its vacatio
courses, for each set of which more than a thousan
applications are received, and whereas in 195
students from foreign countries attending thes
courses outnumbered Colonial students by more tha
four to one, in 1953, Colonial students were in exces
by three to two. The value of these courses, like tha
of the various surveys and study visits, which ar
arranged by the Council but paid for mainly by th
students themselves, lies in the fact that they enabl
students from different parts of the world to live fo
a time together and to get to know one anothe
and make it possible for them to see something o
the practical sides of their subjects of study, to vis
different parts of the United Kingdom and to mee
a wide cross-section of the British public.

In London, and in the areas outside London wher
the Council has staff, there is either a centre fo
overseas students organized by the Council, or th
Council is associated with an international club mai
tained for a similar purpose. Such centres provid
a place where overseas students can meet each oth
and to which they can invite their British friends
and by enabling the Council's staff to get to kno
students individually, they also facilitate the arrang
ment of suitable hospitality for students in Britis
homes. The activities of the centres are particular
useful in areas where there are large numbers
industrial trainees or non-university students.

London, however, presents problems which ha
never been satisfactorily solved, although some
the experiments in London boroughs have succeede
to an extent which has seriously overtaxed the sma
staff available In 1953, the Council issued mo
than 9,500 invitations to overseas students to me
British people in their homes, or in societies or club
and some 1,700 students made new friends in this wa
Other organizations are doing similar work, but t
pressure on the British Council's Overseas Stude
Centre in London is such that the membership cou
be increased several times if premises and staff we
available, it has therefore been necessary to lim
membership to 1,200 students. On the whole, t
report suggests that the recommendations of 19
which set the scheme in motion are being ful
implemented so far as Colonial students are co
cerned, although much remains to be done to me

---

* Report of the Work of the British Council for the Year ended 31st March, 1954 Pp v+105. (London British Council, 1954). 2s. 6d

the needs of students from the Middle East and South-East Asia.

There is, nevertheless, no room for complacency as to the work which the British Council is already doing among Colonial students, viewed simply as a complementary factor in Colonial development and welfare, or as to the desirability of increasing its scale and of supplementing it by private effort. If the comments in the debate on November 30 did not sufficiently bring out the bearing of such work on the effectiveness of programmes for technical assistance in the under-developed countries, the broadsheet which was issued almost simultaneously by Political and Economic Planning, "Students from the Colonies" (No 374, November 29, 1954), although only a preliminary account of some of the difficulties which such students encounter in trying to understand the British and to adjust their ideas to life in Britain, gives a sober warning of how much remains to be done. The picture it reveals of frustration, nostalgia, disillusion and optimism, the evidence adduced of unhappiness, discontent and misdirection is disturbing, and not the less so because the tone of some students' criticism of their reception betrays a lack of drive and adaptability that speaks poorly for their ability to participate effectively in Colonial development

Like the comments on this subject in the debate and the review in the British Council's report, this broadsheet indicates the need for some hard thinking matched by constructive action by all bodies concerned with the welfare of overseas students, by the university authorities and by the well-disposed public, whose private hospitality could probably do most to make these potential leaders of the under-developed and Colonial territories firm friends of Britain. That both Government spokesmen should have recognized something of this is to the good, and there should be no need to fear that adequate money will not be forthcoming for the purpose from Colonial Development and Welfare Funds. Government action can only go a certain way, and beyond this—quite apart from the indispensable influence which private bodies and individuals can exert—it would be helpful if there were less disposition to make Colonial development and welfare a matter of party politics.

WAR-TIME RADIOBIOLOGICAL RESEARCH

Biological Effects of External Radiation

Edited by Dr Henry A. Blair. (National Nuclear Energy Series—Manhattan Project Technical Section. Division 6—Volume 2.) Pp xvii+508. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 56s

THIS volume, edited by H. A. Blair, is one of the sixty-odd of the National Nuclear Energy Series. The general preface states that these volumes will attempt to cover completely what has been 'declassified' of the results of research done in the many divisions of the Manhattan Project and the Atomic Energy Commission in the United States. This one presents the results of the major part of the work done during the war period at the University of Rochester on the biological effects of X-radiation and, in collaboration with the Biochemical Foundation of Newark, on the effects of fractionated neutron irradiations

The major part of the material has been already published in scientific periodicals or was embodied in internal reports. While for the history of the subject there is no doubt that a record of these war-time researches will be useful, it is rather difficult to assess the immediate value of a volume which reports researches some ten or more years old, and which many of the authors have put into the present form when their interests were elsewhere.

The volume is divided into three parts Part 1 deals with the effects of single doses of X-irradiation applied to the whole body. Part 2 deals with chronic exposure of the whole body, and Part 3 with the effects of fractionated doses of fast neutrons Presumably, most of the work had as its object information both as to 'tolerance' doses for those exposed to radiation during their work, and as to the effects on individuals exposed to sudden single large doses as a consequence of acts of war It follows that, with the exception of one of the papers—by Spencer and Stern on the relation between mutations and X-ray dose at very low levels—the content of the volume has not much general interest for the biologist, though it has for the radiologist

The paper by Spencer and Stern is one of the first which attempted to establish the genetic effects of radiation at levels so low as merely to double the background. It is therefore one of the first papers to give experimental support to the extrapolation that in respect of their genetic effects there is no lower threshold for radiations, a matter which is even now taken lightheartedly by many.

Among the other papers the biologist not directly interested in radiobiology will find a number of interesting, though disconnected, facts For example, the lethal mean dose of X-rays is about 200 r for a guinea pig, about 300 r. for a dog, 500 r for a rhesus monkey, more than 600 r for a rat and a hamster, and about 800 r. for a rabbit It would be most interesting to find what regularities there are in these species differences between mammals Another interesting point, though well known, is the enormous difference in sensitivity of different tissues of one and the same animal—this not only in the severity of the injury but also in the speed at which it first appears, reaches its maximum, and may gradually vanish For example, in the rat 550 r. produce histologically visible injury of the bone marrow fifteen minutes after irradiation, with complete recovery in forty days. In the testis the damage appears at six hours and recovery begins only after forty-two days

Injuries to finger-ridge detail, both experimentally produced in monkeys, and detected in a sample of professional groups liable to irradiation (radiologists, orthopædists and dentists), reveal characteristic effects. 68 per cent of 1,033 radiologists, 55 per cent of 185 orthopædists and 40 per cent of 503 dentists showed detectable finger-ridge changes as compared with 1·8 per cent in a sample of 1,850 controls.

A number of other interesting findings of this kind are dispersed throughout the volume. For example, a chapter by R. D Boche reports the effect of chronic X-irradiation on the length of life. There seems to be evidence that even as low a dose as 0·1 r. per day may shorten the expectation of life of rats No doubt by now experiments of this kind will have been repeated and vastly extended. It is essential for the peaceful development of atomic energy that knowledge of this kind should be made available without delay G PONTECORVO

APPLIED STATISTICS

Statistics for Technologists

By C G. Paradine and B H P Rivett. Pp vii+288 (London English Universities Press, Ltd, 1953) 25*s* net.

Statistical Methods in Electrical Engineering

By Dr. D. A. Bell Pp. viii+175 (London Chapman and Hall, Ltd, 1953) 25*s* net.

ANY book on statistical methods for a special group of readers is vulnerable from two directions—its development of the subject itself, and its suitability for the class of reader at which it is aimed.

"Statistics for Technologists" develops fairly logically those parts of the theory of statistics which its authors include (Unfortunately, work-study teams wrestling with congestion problems will find no help here.) The approach could be improved, however, by more explanation of the general principles involved in significance testing The authors are obliged, in their chapter on sampling inspection schemes, to mention briefly the two types of error involved in significance testing, and it would be helpful if some more detailed discussion of these underlying ideas could be inserted before the demonstration of particular tests

It is perhaps a general criticism that although most engineers and scientific workers could comfortably digest the mathematics used, the basic statistical ideas, which are more difficult for the non-statistician to grasp, merit a little further explanation Also, the way in which the examples are used to illustrate the text is not entirely satisfactory in a book specifically for technologists. Although many of these examples come from technological sources, on the whole they lack the circumstantial information which would illustrate to the student the sort of difficulties involved in practical application It may be argued that applying theory requires only common sense, but common sense is greatly helped by the experience of others With these reservations, this book is an adequate introduction to statistical methods for the mathematically minded reader, whether technologist or not.

In contrast, "Statistical Methods in Electrical Engineering" can scarcely be considered as in any way satisfactory in its present form The result of narrowing the topics discussed to the field of electrical engineering has been to destroy continuity in the treatment of statistical methods Only in the last two chapters, where the author deals with electrical fluctuations and information theory, does the book become at all convincing The looseness of construction of the previous chapters can only result in confusing the reader who does "not wish to embark upon a statistician's course of study" For example, the author needs to use Bayes's theorem to derive the expression for the information content of a signal He therefore discusses Bayes's theorem in his first chapter on probability, and states that it is controversial, but the quotations from Fisher and Jeffreys do not make it clear that it is the assumptions necessary to apply Bayes's theorem that caus disagreement, nor does he state what these assumptions are. Again, the use of the word parameter t describe the sample variance and "Student's *t*" wi be irritating to the statistician and confusing to th non-statistician. It has perhaps even confused th author, for he makes the statement that "the rando error of the answer deduced from the total of (N observations is approximately $\sqrt{N}$ times less than one relied on a single experiment (*actually* $\sqrt{N-}$ which tends to $\sqrt{N}$ when N is large)". The omissio of any discussion of congestion theory is even mo noteworthy in this book than in the previous on for the greater part of the theory was developed b Erlang and his successors specifically for electric engineers concerned with telephone exchange problems, and an up-to-date definitive text has still t appear Finally, it is surely superfluous in th appendix listing statistical tables to devote thre separate sections to the different forms in which th normal integral is tabulated F DOWNTON

AUTOMATIC DIGITAL CALCULATING MACHINES

Automatic Digital Calculators

By Dr. Andrew D. Booth and Dr. Kathleen H V Booth. Pp vii+231+4 plates (London Butterworths Scientific Publications, 1953) 32*s* net.

AUTOMATIC digital calculating machines, thoug increasing in number and variety, are still no very numerous and are still news, rather sensationa in the public mind The idea that a calculatio involving many digits can be performed in a matte of milliseconds is one that implants despair i certain temperaments, and breeds a curious brand o mechanical mysticism in others The remedy fo such reactions is to read a straightforward an objective book on the historical development an present status of such calculation, and for th purpose the book under notice seems admirable. Th authors have the practical and theoretical qualifications, experience with different types of computin machine, enthusiasm for the subject, and a clear an unassuming style of exposition

The historical introduction is brief, so far as i refers to dates earlier than 1940 The initiator is, o course, Charles Babbage, whose wilful face stare from the pages of any history of calculation, a ma whose imagination was exact regarding the possibilities of machine calculation, but far ahead of th mechanical resources available in his own age, a man unable, however, partly through temperament to retain the sympathy of the government of th time or the continuation of financial support. Hi ambitions foundered in 1842, so that it was almos a century before the coming of electronic technique enabled those dreams to be more than realized. Th third chapter of this book summarizes the rapi advances that took place between 1940 and 1950

Several chapters of a descriptive kind follow, i which the technicalities of input, output, control an the various operations, addition and subtraction multiplication, division and others of miscellaneou nature, are detailed in the clearest manner wit excellent diagrams Chapters on storage follow, an here unfortunately the word 'memory', with it misleading anthropomorphic associations, seems entrenched in the literature and hard now to dislodge

Lastly, there are chapters on coding and coded routines, illustrated by square root, interpolation and the like, and that question of mechanical translation from one language to another which aroused newspaper controversy and misunderstanding not long ago

Concluding sections deal with the "playing of games" by machines, and "machine learning and intelligence" Here the reviewer, having followed so far with interest and profit, found himself in mental opposition to such phrases as "conditioned reflex" of a machine, or its "awareness" But perhaps these pages of Erewhonian speculation are merely a fanciful epilogue In any event, they do not detract from the value of a very good and compact book, rather costly for its 240 pages, but probably indispensable in the growing literature of texts dealing with electronic calculating machines

A C AITKEN

ENZYMES, GENES, VIRUSES AND BACTERIA

Annual Review of Microbiology

Edited by Charles E. Clifton, in association with Sidney Raffel and Roger Y Stanier Volume 8, 1954 (Stanford, Calif Annual Reviews, Inc , 1954) 7 dollars

THE need for regular, critical surveys of recent work which are something more than lists of references with titles, but at the same time less detailed than articles in the standard review periodicals or "Advances" series, is uncontested Indeed, publications in the "Annual Review" series have become an essential aid to biological research and are a partial answer to the appalling quantity of scientific literature which now faces the research worker

The extent to which recent work can be subjected to reasoned criticism in these series is severely limited by lack of space It is, however, variable and therefore apparently left in some degree to the discretion of contributors It would be unfortunate if the opportunity for comment were subjected to any further restriction Even at the risk of a more individual approach and the relegation of some papers to a bibliographical list printed as an appendix without comment, a review article should aim at critical assessment of at least some of the work done on a particular subject

One example, in this volume, of what can be done is the comprehensive and extremely useful review on "Genetics in Micro-organisms" by S Spiegelman and D E Landman This is a real *tour de force*, with 481 eferences cited in fifty-six pages of condensed, almost telegraphic, English It is readable, but exhausting

In general, the articles are widely and fairly distributed among different fields general microbiology, 5 , bacteriology, 6 , viruses, 5 , immunology, , protozoology, 2 , and mycology, 1. Selection for omment is always apt to be misleading, and must be taken largely as an indication of the reviewer's particular interests

The most striking impression obtained is that of he remarkable and fascinating advances made in he study of bacteriophage and in bacterial genetics Workers in other fields must envy the way those studying phage reproduction and genetics have broken through into the open during the past five years This is clearly illustrated by a short and excellent review, by E A Evans on "Bacterial Viruses", which is easily assimilated, even by those unfamiliar with the subject

The important recent advances made in the study of viruses grown in tissue cultures (with special reference to poliomyelitis virus grown on human or monkey cell homogenates) have been reviewed in a very helpful and thoughtfully written article by J F Enders

Among other articles of special value and interest is one by A H Coons on "Labelled Antigens and Antibodies". Fluorescent, iodinated, coloured, chemically marked and isotopically labelled proteins are being used on an increasing scale in the study of antibody formation C. L. Oakley has written a characteristic review on "Bacterial Toxins" where he describes in some detail the intricate, immunological analysis of culture filtrates containing several different, physiologically active proteins He suggests the term 'soluble bacterial antigens' as a substitute for 'toxins'. One can sympathize with some of his feelings , but, if there is going to be a change, why not move straight towards a biochemical basis of nomenclature ? It should at least stimulate more badly needed biochemical work on the characterization of these substances

In microbial metabolism the importance of coenzyme A is becoming increasingly recognized, as emphasized by J. R R Campbell in an article which includes four pages on recent advances in the study of adaptive enzymes. W. W Umbreit devotes fourteen pages to "Mechanisms of Antibacterial Action" in an article which is useful largely in indicating how extraordinarily little is known about these mechanisms. His implication that the mode of action of penicillin and streptomycin is now more or less understood is—in spite of some important work on streptomycin (particularly by himself and colleagues) —somewhat misleading

In a review of "Changes in the Host Flora induced by Chemotherapeutic Agents", E McCoy stresses the increasing proportion of bacterial strains found resistant to penicillin or streptomycin (especially in hospital infections, where it can be as high as 80 per cent) and more recently, to chlor- and oxy-tetracycline and even to erythromycin. So far, instances of cross-resistance are not numerous , but the outlook is not encouraging

There are two articles on bacterial cytology a useful review by S Mudd on the "bits and pieces" of bacteria (flagella, capsules, cell walls, mitochondria, microsomes, etc) , and a more difficult article by E. D DeLamater on "The Bacterial Nucleus" It is unfortunate that a rather bitter controversy on the mechanism of nuclear division (and other matters) should have obscured some of the genuine advances made in this field

It is difficult not to be impressed by the almost overwhelming advantages offered by work on micro-organisms in the pursuit of nearly every kind of biological problem It would be understandable if impatient physiologists, biochemists, virologists and geneticists now working with plants or mammals were tempted to drop their present occupation and concentrate for ten years on analogous studies on a convenient, non-pathogenic species of bacterium in order to make some rapid discoveries which would almost certainly be immediately applicable to their original research problems

M R POLLOCK

COLONIAL RESEARCH IN THE BRITISH COMMONWEALTH

THE first annual report of the Colonial Research Committee was published in May 1944 as a slender Command Paper of eleven pages The second annual report was issued in August 1945, along with those of the Colonial Products Research Council and the Colonial Social Science Research Council, under the title "Colonial Research, 1944–45", a Command Paper of 31 pages Now, "Colonial Research, 1953–54" is a substantial publication of 278 pages* Besides the annual reports of the three original bodies, it contains the ninth annual reports of the Colonial Medical Research Committee and of the Committee for Colonial Agricultural, Animal Health and Forestry Research, the seventh annual reports of the Colonial Insecticides, Fungicides and Herbicides Committee and of the Colonial Economic Research Committee, the Colonial Fisheries Advisory Committee's annual report on fisheries research for 1953–54, and the reports for 1953–54 of the Tsetse Fly and Trypanosomiasis Committee and of the Director of the Anti-Locust Research Centre, as well as reports on miscellaneous matters not covered by the reports of the specialist advisory bodies

All these reports include lists of reports and other publications issued during the year , but neither in the brief report of the Colonial Research Council nor elsewhere is there, however, any attempt at a considered conspectus of the work of these ten specialist bodies and its bearing on Colonial development and welfare work generally and in relation to British resources and research activities as a whole The nearest approach to such a survey is provided by the list of research schemes approved under the Colonial Development and Welfare Acts in 1953–54 and in the comments of the Colonial Research Council on those schemes There may well be some administrative convenience in publishing these annual reports *en bloc* , but the title is something of a misnomer unless it is accompanied by some general survey or summary directing attention to the most important implications for Britain's commitments in research, for Colonial development and welfare and for technical assistance to the under-developed areas Such a survey is now well overdue and in its absence less than justice is being done to the British effort

The forty-two new schemes and forty-nine supplementary schemes made during the year, involving grants totalling £728,510, brought the net expenditure and commitment from Colonial Development and Welfare Funds since 1940 to about £12 million at March 31, 1954 Of the gross allocation of £13 million, about 33 per cent has been for agricultural, animal health and forestry schemes, 15 per cent for medical research, 12 per cent for fisheries research, 10 per cent for tsetse fly and trypanosomiasis research, 9 per cent for social science and economic research, 8 per cent for insecticides research, 5 per cent for research sponsored by the Colonial Products Research Council, 3 3 per cent for anti-locust research and 4 6 per cent for miscellaneous schemes, including building and road research About 40 per cent has been for schemes to benefit the East African territories, 19 per cent for the West African group, 10 pe cent for the South-East Asian territories and Hong Kong, 8 4 per cent for the West Indian Colonies British Guiana and British Honduras, and 5 6 pe cent for the Central African territories.

Of the major schemes approved during the year the largest are £123,743 for the establishment of the West African Council for Medical Research , £110,00 for continuation of research at the East Africa Veterinary Research Organization , £66,984 for the maintenance of the West Indian Institute of Socia and Economic Research , £44,809 for control o malaria in the hyper-endemic area of Taveta-Parc East Africa , £31,330 for the continuation of suga technology research at the Imperial College o Tropical Agriculture, Trinidad , £20,492 for researc in Jamaica into the 'unknown' disease of coconut and Panama disease of bananas , £18,750 for th preparation at the Royal Botanic Gardens, Kew, o the "Flora of Tropical East Africa" , £16,000 for th establishment of the malarial unit in East Africa £16,022 for investigation into the control of filariasi in Fiji by insecticidal methods , £14,915 for researc in Malaya on virus and other diseases transmissibl from animals to men , £14,780 for the establishmen of a Fungicide Research Unit in West Africa , £14,30 for banana-breeding research in Jamaica , £13,52 for the establishment of a pool of Colonial soil surveyors , £12,290 for the expansion of the Veterinar Research Laboratory, Vom, Nigeria , and £12,25 for the maintenance of the West African Institute fo Trypanosomiasis Research

The eleventh annual report of the Colonial Product Council, which on January 1, 1954, replaced the Colonial Products Research Council and has assumed responsibility for the general supervision of the Colonia Products Laboratory (formerly the Colonial Product Advisory Bureau), notes that eighty investigation were carried out in the Laboratory and 786 inquirie handled. Investigations on West African groundnut continued, with particular reference to the effect o insect attack on quality An improved technique fo assessing insect infestation in maize was devised fo use in Colonial territories, and African methods o preparing gari from cassava are being studied wit the view of mechanizing the process Good progres is reported in building up a reference collection o photomicrographs of fibres obtained from botanicall authenticated plants Some experimental work wa carried out on the chemical retting of cotton stal fibre and *Hibiscus cannabinus* with the view of determining which of the commoner and cheaper chemical could be used Pulped by the sulphate process, bata wood (*Albizzia falcata*) from the Federation of Malay gave a pulp comparing very favourably with coniferous sulphate pulps, and a mixed sulphate cook o three species of timber from Kenya gave a bleache pulp suitable for incorporation in printing or writin papers Good-quality pulp suitable for high-strengt papers was obtained from ribbons of *Hibiscus cannabinus*, obtained in work in Nigeria on the mechanized production of stem fibres

---

* Colonial Office Colonial Research 1953–54 Reports of the Colonial Research Council , Colonial Products Council , Colonial Social Science Research Council , Colonial Medical Research Committee , Committee for Colonial Agricultural, Animal Health and Forestry Research , Colonial Insecticides Committee , Colonial Economic Research Committee , Tsetse Fly and Trypanosomiasis Research Committee , Colonial Fisheries Advisory Committee , Director—Anti-Locust Research Centre , and Research Matters not covered by the above Reports of the Specialist Advisory Bodies (Cmd 9303) Pp 278 (London H M Stationery Office, 1954) *7s 6d* net

Work on the chromatographic separation of the active principles of pyrethrum flowers has led to a method for the separation and spectrophotometric determination of the pyrethrin I and pyrethrin II fractions A comprehensive investigation of the assay of the proteolytic enzyme pepsin (the dried latex from the fruit of the paw-paw tree, *Carica papaya* L) was commenced Further work on Colonial sources of essential oils rich in safrole has indicated that distillation of the wood and bark together of 'medang kerangas' should give an oil containing more than 80 per cent of safrole Extensive work on eugenol and its derivatives has indicated that eugenol dibromide is of interest for the preparation of soluble vicinal dithiols for preventing poisoning by heavy metals, and that 1-(3′ 4′-dimethoxybenzyl)-5-propyl-7 8-dimethoxy*iso*quinoline hydrochloride has an interesting biphasic effect on blood pressure Work on groundnuts continued, but trade trials of sugar-cane wax in pastes, cream polishes and emulsions have been disappointing, and little progress has been made in finding a market for the wax Attempts are being made to determine the constituents of mangrove bark responsible for the objectionable dark colour of the extract. Work on carbohydrates included the isolation of a range of dextrans by growing bacteria and moulds on cane sugar, the isolation from cultures of *Betacoccus arabinosaceous* of the dextran-synthesizing enzyme dextransucrase in complex formation with dextran, study of the glucamylase of *Aspergillus niger*, the synthesis of fluorine derivatives of sugars and sugar alcohols and the production of cellulose from industrial wastes.

The performance of the experimental sugar factory at Trinidad in 1953 compared well with its performance in 1952, and modernization is now almost complete Considerable advance has been made in clarification studies, and a system has been devised for cleaning sugar factory evaporators when coated with the most intractable of scales Conditions have been established for converting molasses into lævulinic acid and isolating the product. A more extended study of the fermentation of cocoa beans is being undertaken, and methods have been developed for the determination of each polyphenolic component of fresh and cured cocoa beans Besides the microbiology of jute, the nature of the pectic substances of the plant has been explored

The tenth annual report of the Colonial Social Science Research Council records as the principal difficulty the recruitment of senior staff Of the five American social scientists appointed under the special scheme for training American social scientists at British universities, Mr E H Winter has joined the staff of the East African Institute of Social Research and Mr and Mrs A Harris are returning to work in association with that Institute under the project for the study of African leadership, for which the Carnegie Corporation of New York has given £30,000 A Social Research Unit of three research Fellows was set up in the University of Malaya, but no successor had been found to Prof. W. Hamilton Whyte as director of the West African Institute of Social and Economic Research A linguistic survey of the British Caribbean Colonies is being undertaken by the University College of the West Indies, while at the University of Hong Kong the research programme has been very much extended Studies under Prof E H. G Dobby at the University of Malaya have covered land-use and tenure in Langkivi, the conservation of resources in Selangor and the human ecology of the fishing villages near Kuching, Sarawak Among studies undertaken by Colonial administrative and specialist officers during the year, special reference is made to Dr W. L I Verrier's research into the demography of Fijians, the research by the Rhodes–Livingstone Museum into prehistoric archæology in Northern Rhodesia and the adjacent territories and into the material culture of Northern Rhodesian tribes, particularly the Hukwe Bushmen and the tribes of Southern Barotseland, and the anthropological research by the Sarawak Museum on the Kelabits of the far interior, on group contacts and conflicts, and on native legend with particular reference to migrations and geography.

Nine further sections of the Ethnographic Survey of Africa were published during the year, making a total of twenty-four volumes Of the "Handbook of African Languages", Part 3 of the General Survey, "Non-Bantu Languages of North-East Africa", was in the press, and a special study, "Bantu Languages of Western Equatorial Africa", by M Guthrie, was published during 1953 A number of other projects have been completed for publication, and lists of these items and of publications during the year by workers assisted from Colonial Development and Welfare Funds are appended to the Council's report, together with the annual reports for 1953–54 of the Directors of the East African Institute of Social Research, the West African Institute of Social and Economic Research, the Institute of Social and Economic Research, the University College of the West Indies, and the Rhodes–Livingstone Institute, and the report for 1953 of the Educational Research Institute for Fiji and Western Pacific Territories.

To the nineteen established research schemes under the scientific supervision of the Colonial Medical Research Committee at the beginning of the year, two major long-term schemes have been added a field study of schistosomiasis in the Gambia, and a three-year study of the effects of changing temperature on insect physiology and behaviour, with special reference to insect relations to climatic conditions in the tropics The Committee's ninth annual report records the filling of five further vacancies and the posting of three research students—one overseas and two in London In February 1954,, under a financial scheme made by the Committee, a five-day conference on virus diseases was convened in Kuala Lumpur, with Prof P A Buxton as chairman The conference included, besides British and American workers from the Institute there, investigators from South Africa, East Africa, the Sudan, Australia, the American Army and its Graduate and Research School at Washington, the Rockefeller Virus Research Unit at Poona, the Malayan Medical Service, the University of Malaya, the Armed Forces in Malaya and the Colonial Office The meeting was concerned primarily with assessing the potential hazard of yellow fever, but discussions ranged over the wider field of arthropod-borne virus diseases, and comprehensive recommendations were made for relevant investigations. The Committee has also convened a conference of experts available in the United Kingdom, under Brigadier J. S. K Boyd as chairman, to review the present scientific position of the sickle-cell trait and sickle-cell anæmia and to advise it on suitable lines of investigation The Helminthiasis Sub-committee, having considered, in connexion with schistosomiasis, the pressing need for clarifying the present confusion in the identification of African snails carrying schistosomes and for correcting the over-emphasis hitherto placed on conchological evidence only, has directed attention to the desirability of having men trained in malacology, and of instituting a centre at which continuity of malacological studies could be maintained To meet these needs, it recommended that a Government research fellowship should be made available at the British Museum (Natural History) for research on snails in relation to schistosomiasis and other fluke infections of man and his domestic stock and their control Ten members of the Committee and Sub-committees visited various units in the field, and facilities of the research units continued to be much used by research workers from the United Kingdom for the short-term study of specific problems

The East African Standing Advisory Committee for Medical Research has recommended the establishment of a special unit to carry out demographic studies and to compile the vital statistics so essential as a background for many problems in medical research. The East African Government has approved the proposal to set up a council for Medical Research in East Africa as a corporate body. The Helminthiasis Research Unit at Kumba, British Cameroons, concentrated its work on loiasis and its transmission by *Chrysops* on obtaining as complete a picture as possible of the life-cycle of the principal vector, *C silacea*, and a comprehensive knowledge of its habits, food requirements and movements, and on ascertaining the identity of the species of filarial worms found in the monkey population of the forest canopy and whether the filariæ in the monkeys are the same species as those occurring in man, and also whether they develop in the same species of *Chrysops* It has been established that the migrating filariæ of *L. loa* develop not only in *C silacea* and *C dimidiata* but also in *C langi* and *C zahrai*, and an almost continuous census has been maintained of the infection-rate in the human and fly populations both at Kumba, where monkeys are common, and at Sapele, where they are absent Lack of staff restricted the mapping of the incidence of bancroftiasis in Tanganyika and in part of Kenya, but it is estimated that in Tanganyika two million people harbour the parasite Random sampling of populations in Kenya indicates that onchocerciasis is extremely common in the high hills cupping the north-east portion of Lake Victoria

Under the filariasis research scheme commenced in Malaya in July 1953, the main work is to be done in heavily infected hamlets along the lower reaches of the Pahang River in East Pahang, with headquarters at Kuantan. A pilot mass-treatment campaign indicated that the main difficulties inherent in any attempt to control Malayan filariasis by treatment with 'Hetrazan' or Banocide' are erratic attendance at the drug-parade, the occurrence of febrile reactions in about one-fifth of the persons whose bloods contained no microfilariæ, and the development in many persons of symptoms of intolerance to doses of the drug which had been borne quite well by patients in hospital

Investigations on guinea-worm at University College, Ibadan, were aimed at providing specially designed wells in selected rural areas in the heavily infested zones as a practical prophylactic measure, and laboratory studies on the early stages of development of the guinea-worm in the mammalian host, using puppies as the experimental animals The East African Malaria Unit at Amani has been expanded, making possible a more rounded attack on malaria problems, and the total *Anopheles* population in a particular district has been estimated by a system of mass spray-catching in houses In studies on the existence of biological races in *A gambiae*, the maxillary index in wild-caught specimens and in females bred from two different strains of this species maintained as laboratory colonies was investigated Sprayings with residual insecticides on a sugar estate in Northern Tanganyika indicated that the average dosage of 1 5 gm per sq m of 'Gammexane' dispersible powder is required to maintain a low anopheline house population, but such a treatment had no apparent effect on the parasite-rate of the adult estate population In Nigeria the Ilaro Experimental Control Scheme was concluded and an assessment of long-term suppression of malaria in three hundred African school children is in its second year Studies of the newer anti-malarial drugs continued at the Institute for Medical Research, Kuala Lumpur, and the effect of residual insecticides on Malayan mosquitoes was also examined

At the West African Virus Research Institute, Lagos, an *in vitro* test for detecting yellow fever antibodies is being developed, and the East African Virus Research Institute, Entebbe, investigated an epidemic of dengue-like fever in Newala District, Southern Tanganyika, and has shown that *A aegypti* was the main vector Work continued on virus–tissue relationships, on the virus of Rift Valley fever, and on the hatching impulse in eggs of mosquitoes of the genus *Aedes* Epidemiological investigations at the Trinidad Regional Virus Laboratory indicate the presence in certain areas of Trinidad of a virus agent closely related to, or identical with, Ilheus virus, which is immunizing a considerable proportion of the population

In a summary of observations made by the United States Army Medical Research Unit in Malaya, reference is made to a long-term study of the incidence and manifestations of arthropod-borne viral infections of humans in Malaya and their ecology, to an exploratory survey which indicates that leptospirosis is very prevalent in man, domestic animals and wild rodents in Malaya and emphasizes the importance of the primary jungle as an endemic focus, and to field studies in North Borneo which indicate that 'Dieldrin' and 'Aldrin' provide an effective and practical means for controlling the mite vectors of scrub-typhus through the disinfestation of terrain

Investigations on relapsing fever in East Africa are now being concentrated on the south-western regions, where the disease is much more prevalent At the Lister Institute of Preventive Medicine, London, the inhibition test for the identification of blood-meals of closely related species has been established as a routine measure Work on acclimatization in insects at the London School of Hygiene and Tropical Medicine has confirmed that the chill coma temperature and the ability to survive cold can be substantially modified by keeping several insects for twenty-four hours or less in warmer or cooler conditions within their normal zone of activity, and has also shown that tolerance to temperatures at the upper limits can be altered. Academic studies at the Hot Climate Physiological Research Unit, Nigeria were mainly concerned with nutrition; but the Unit has also made observations of working conditions in the Enugu Colliery and physiological observations on a training march of the Fourth Battalion of the Nigeria Regiment which are of value to civilian as well as to Service authorities. Evidence has been obtained which suggests that the sickle-cell trait affords much protection against subtertian malaria; in Nigeria, where 'Dapsone', as elsewhere, is now the routine treatment for leprosy, a three-year study of thiosemicarbazone has given evidence that resistance to the drug develops. Investigations of goitre in Sierra Leone suggest that the chief factor in the distribution of endemic goitre there is the difference in iodine content of the rocks from which the drinking waters and local foodstuffs are obtained.

The East African Medical Survey completed its first phase of five years in December 1953, and its investigations, which have comprised field-surveys to establish pictures of disease in East Africa, laboratory research on methods of control of disease, and pilot schemes to assess the efficiency of these methods, are summarized in the report. There is also a brief summary of work undertaken in the Federation of Malaya on nutrition, of work in Jamaica on vomiting sickness and the psittacosis–lymphagranuloma venereum group, and in Kenya on kala-azar, on the primary reservoir of plague, and the eradication of *Simulium neavei* from onchocerciasis foci by treating the rivers with DDT emulsion.

Grants totalling £235,043 for new and supplementary schemes were made during the year from Colonial Development and Welfare Funds by the Committee for Colonial Agricultural, Animal Health and Forestry Research, the annual report of which again acknowledges particularly the assistance of the Commonwealth Institutes of Entomology and of Biological Control and the Commonwealth Mycological Institute. In East Africa, where all sections of the Agriculture and Forestry Research Organization report progress, glasshouse studies have shown that resistance to *Puccinia polysora* may exist in certain Central American maizes, whereas none has been found in any African type; and that resistance appears to be controlled by a dominant major gene. Evidence has been obtained that in the Aberdare Mountains cypress plantations intercept less water than the natural bamboo cover, and are therefore preferable in conserving underground water supplies. At the East African Veterinary Research Organization, rinderpest research has led to the development of a conglutination test for rinderpest, and field-surveys have shown no evidence that immunity to East Coast fever is produced by recurring clinical disease, although it is probably constantly reinforced by infected ticks. Valuable information has been obtained on the timing of anthelmintic treatment by studies on the development of *Haemonchus* larvæ under field conditions. The joint Animal Industry Division, shared by the two research organizations, has made a promising start, while the four West African Governments have agreed to establish a Permanent Standing Advisory Committee for Agricultural Research.

The West African Cacao Research Institute has opened a sub-station at Moor Plantation, Ibadan, for the study of the somewhat different problems encountered in Nigeria from those of the Gold Coast. Cacao virus studies have revealed five new hosts of swollen shoot virus, and special studies are being made on *Cola* spp. in collaboration with Kew Herbarium, and a chemical method has been developed for the diagnosis of swollen shoot virus in leaves of symptomless trees. The fitting-up of the laboratories of the West African Rice Research Station, Rokupr, Sierra Leone, was completed, and besides research on rice selection and breeding, trials were commenced on the use of hormone arboricides for the destruction of mangroves on land.

At the West African Institute for Oil Palm Research, work was concentrated on agronomy, plant breeding and plant pathology, and is supported by a strong Statistics Division. The breeding programme of the West African Maize Rust Research Unit is now sufficiently advanced for some rust-resistant selections to be grown in multiplication plots for distribution to farmers, and increasing attention is being given to breeding varieties resistant to other diseases and pests, particularly stem borers. Hybridization of the Gros Michel banana with synthetic parents continued at the Banana Breeding Station in Jamaica, the Anglo-Columbian expedition in search of new material for cacao proceeded into 1953, and work continued on shade and nutrient relations, hormone sprays and nutrient injections, iron chlorosis, stock-scion relationships and systems of training young cacao. A detailed ecological survey of cacao estates in Trinidad was commenced.

Among the research undertaken by Colonial Departments and which is recorded in this report may be mentioned the chromatographic investigation, in British Guiana, of the amino-acid distribution in sugar-canes for different 'leaf-scald' reaction; the success obtained in the Gold Coast in control of the common borers attacking maize, *Sesamia* spp. and *Busseola fusca*, by dusting the young plants with DDT fourteen and sixteen days after germination, and the good results obtained by the pasture research section in Kenya in widespread trials with a strain of *Setaria sphacelata* ex Nandi. Promising results in yield, strength of straw, and earliness have been obtained in widespread trials of local varieties of rice in Malaya. In tea research, copper sprays continued to give the best control of blister blight (*Exobasidium vexans*), though copper dusts have also recently given good control. Trials in the destruction of forest weeds in Malaya continued, and in further tests against ambrosia beetles creosote gave good protection to barked logs when applied by brush. The Veterinary Research Institute was opened on June 10, 1953, and its work has so far been directed mainly to the production of vaccines for immediate field-use and to the diagnosis and confirmation of live-stock disease from specimens submitted by field-officers. In Nigeria a new study of the effect of green manure on land depleted of organic matter was started, while the Forest Research Branch, Ibadan, continued to investigate the regeneration of the high forest, particularly with the view of decreasing costs of regeneration. At Zanzibar the premature nut-fall and gummosis of coconuts caused by the Coreid bug *Theraptus* and other insects were further investigated, and preliminary spraying trials indicated that 'Dieldrex' is the most effective insecticide for the control of the more serious *Anophelepsis custodiens*.

The seventh annual report of the Colonial Insecticides, Fungicides and Herbicides Committee includes, as usual, an account of the work of the Colonial Insecticide Research Unit at Porton, where in studies on the behaviour of urea-formaldehyde resins containing insecticides it was found that non-blooming films containing low concentrations of 'Dieldrin' possessed a high residual toxicity to some insects. Particularly promising results were obtained in laboratory tests of granular insecticides as larvicides, and the engineer attached to the team succeeded in fitting a rotary brush-spray unit to an Anson XIX aircraft and testing its operation, as well as fitting a hopper for pelleted material to a D H Beaver aeroplane At the Imperial College Field Station work continued on the penetration of the insect integument by DDT solution, the contamination of flies by particulate deposits and the olfactory stimulation of tsetse flies At Long Ashton Research Station trials continued on the adhesion of copper fungicidal spray deposits to foliage with and without stickers, while the work at Rothamsted was again concerned with the loss in toxicity of DDT deposits on foliage and on glass plates under simulated tropical conditions, and the prevention of such loss. The Research Unit at Arusha continued to work on the same lines as last year, and a reduction of tsetse fly of more than 99 96 per cent was achieved by large-scale aerial spraying with DDT at Maruzi, Uganda. Other work was concerned with the defoliation of bush and control of weeds, of mosquitoes and of grain-eating birds. Good progress was made in establishing the research unit at Ilonga, Tanganyika The investigation of the ecology and habits of *Anopheles gambiae* in Mauritius, filariasis research in Malaya and research on defoliants in East Africa continued the latter investigations indicate that aircraft application of *n*-butyl 2 4 5-trichlorophenoxyacetate will defoliate a wide range of species of trees

Other work noted in the report is that in Malaya on the trials with 'Dieldrin' against *Anopheles maculatus*, *A. sundaicus* and *Culex fatigans*, and on the destruction of forest weeds, that with 'Dieldrin' in Tanganyika for control of white coffee borer, *Anthores leuconotus*, and that of the Mosquito Control Service in British Guiana on the bionomics and control of *Culex fatigans* and the comparative toxicity to its larvæ of DDT, BHC, 'Chlordane', 'Dieldrin', 'Aldrin' and other insecticides

The Colonial Economic Research Committee still finds difficulty in attracting native scholars to work in the Colonial Territories, but has been able to secure excellent candidates for its new projects. Dr F. C. Wright completed his study of the structure and organization of the distribution industry in Tanganyika and Nyasaland Dr Ida Greaves was preparing a report on the methodology of capital formation studies with special reference to Jamaica, Mr D T Edwards was making a detailed study of the economics of small farms in Jamaica, and Mr A D Knox was completing a study of the development of trade between British West Indian territories, past and present Mr F H H King was studying the monetary systems of the Far East At the beginning of the academic year 1952–53, a research division was established, with Colonial Development and Welfare and Gold Coast Government funds, within the Department of Economics of the University College of the Gold Coast

The report for 1953–54 of the Tsetse Fly and Trypanosomiasis Committee reports good progress in the construction of the Central Trypanosomiasis Research Laboratory at Sukulu for the East African Tsetse Fly and Trypanosomiasis Research and Reclamation Organization, but the shortage of qualified officers continued until late in 1953 Studies of *G. morsitans* continued throughout the year, and research on *G pallidipes* has been undertaken in the Lambwe Valley (Kenya) and in the Busoga district of Uganda Field-trials of the role of biting flies have shown that 37 5 per cent of a small herd of cattle contracted *T. congolense* infections over a period of ten months in 1953, and 17 0 per cent of another herd after exposure for six weeks In field-experiments, regular administration of 'Antrycide' at two-monthly intervals for a limited period daily protected cattle against *G austeni* even after the cessation of treatment Experimental reclamation and pilot schemes in the three East African territories proceeded according to the general plans The West African Institute for Trypanosomiasis Research reports that *T vivax* is not only the species of trypanosome most commonly found in zebu cattle in Northern Nigeria, and probably elsewhere in West Africa, but also that in some localities this species is capable of causing a high proportion of deaths of the host Factors governing its transmission by *G palpalis* have been further studied, and studies on the tolerance of Ndama cattle to trypanosomiasis continued Further experience indicates that 'Antrycide' methyl sulphate gives uniformly satisfactory results in treatment of zebu cattle infected with trypanosomiasis in West Africa, and recent experiments have shown that 'Antrycide'-resistant strains of *T. congolense* became progressively less resistant after serial passage

Work on the use of 'Melarsen' in the treatment of human trypanosomiasis continued in collaboration with the Nigerian Sleeping Sickness Service, and prophylactic 'Pentamidine' has proved an efficient, safe and rapid means of reducing the incidence of sleeping sickness in a population of 2,500 in a selected area in Northern Nigeria

The annual report on fisheries research for 1953–54 of the Colonial Fisheries Advisory Committee reports vacancies for five scientific officers at existing research stations and an uncommitted balance on March 31, 1954, of £116,000, against which provision for new schemes and the extension of existing schemes to March 31, 1956, is estimated to total £80,700. The Inter-territorial Fisheries Research Station at Jinja, Lake Victoria, collected a comprehensive series of hydrological data, giving a better understanding of the complicated water movements in this Lake, and these movements have been related to the variable growth of plankton in certain areas Observations on the rate of growth of *Tilapia* indicate that the quality of the food may be more important than the amount eaten A thorough investigation has been made of the physical and chemical conditions obtaining in papyrus and water-lily swamps At Zanzibar a comprehensive report has been written on the pelagic fishes, the taxonomy and distribution, the gear used in trolling and the various types of lures employed, but the joint Northern Rhodesia-Nyasaland Freshwater Research Station, which has now moved to Nkata Bay, Lake Nyasa, for a two-year investigation of the Lake, was able to carry out very little research on Lake Bangweulu owing to building delays The West African Fisheries Research Institute's studies of the movements, growth breeding and feeding habits of twenty-seven species of endemic marine and brackish water fishes have shown that catches of *Drepane* species are affected by the phases of the moon.

The Fisheries Research Unit at the University of Hong Kong is now well established

The report of the Director of the Anti-Locust Research Centre on locust research and control during 1953–54 emphasizes the need for additional accommodation The present quarters are inadequate for the personnel, and while requests from abroad for the accommodation of research workers and students have to be refused, the recording and summarizing of current information on the developing plague of the desert locust continues to delay the progress of the research work essential for long-range planning of international anti-locust measures During the year, 1,363 reports on the locust situation were received from thirty-eight countries and territories and the desert locust situation continued to deteriorate The plague has extended almost to the maximum area liable to invasion, the intensity of infestation is likely to increase and exceptional efforts were required from the Desert Locust Control to reduce the dangers of devastation of East Africa, which was seriously invaded Inadequate support by countries to the Food and Agriculture Organization's initiative for locust control in the Arabian peninsula led to large escapes from Arabia and elsewhere, which were responsible for the alarming increase in the infestations over the whole of the northern half of Africa and south-western Asia as far as India Nevertheless, the research activities of the Desert Locust Survey are continually expanding and bearing fruit, and the International Council for the Control of the African Migratory Locust has also created a permanent research service

Some miscellaneous matters not covered by the reports of the specialist advisory bodies are this year relegated from the report of the Colonial Research Council to a special section at the end of the report These include the research of the African Studies Branch of the Colonial Office into problems of African administration such as land tenure and land policy, that under the Colonial Liaison Organization of the Building Research Station into the durability of paint, solar water-heating and climatological studies, and that of the East African Industrial Research Board and of the Colonial Road Research Advisory Committee, which refers particularly to problems of road construction in Malaya, Singapore, Sarawak, Brunei and North Borneo Recruitment of field-staff for geodetic and topographic surveys kept just ahead of transfers and resignations, very satisfactory progress was made with geodetic surveys, the survey of control for mapping required for the Volta River project was completed and the output of mapping increased owing largely to fewer changes of priority

The overseas scientific staff of the Colonial Geological Surveys increased from 190 to 197 during 1953, but twenty posts were still vacant Satisfactory progress continued in all branches, including geological mapping, the investigation of mineral resources and the geological aspects of engineering and water-supply projects The shortage of qualified meteorologists continued to restrict research work, but the East African Meteorological Department is studying problems connected with the artificial control of rainfall In Mauritius, research on the correlation between rainfall deficits and excesses at the various seasons and the tonnage and sucrose content of the sugar-cane crop is expected to provide a more accurate guide to the tonnage of cane to be crushed and the probable total sugar production each year

At the National Institute of Oceanography, the study of oceanic water movements is intended to have first place in the programme of research in marine physics, but progress is slow. Researches in marine physics are being linked as closely as possible with the biological work.

MECHANISM OF INTESTINAL ABSORPTION OF FAT

By Prof A. C. FRAZER

Department of Pharmacology, University of Birmingham

FIRM progress in biological research is dependent on the proper use of hypothesis From time to time a generally accepted view in some field of study may be shown to be wrongly based, and in this case a new hypothesis is needed to replace the old But, n the change over from old to new, misunderstanding and confusion may arise Such has been the case in he field of fat absorption A statement of the main facts may help to correct this situation

The story begins with the lipolytic hypothesis of Pfluger[1], which was put forward at the turn of the entury and generally accepted as the basis for the at absorption mechanism The essential features f this hypothesis were the necessity for complete hydrolysis of glycerides, absorption of lipids from the ntestinal lumen in water-soluble form only, re-ormation of glycerides in the intestinal cell and assage of particulate glycerides in the chyle, giving ise to the alimentary hyperlipæmia in the systemic lood. In 1936, Verzár and his colleagues[2] introduced ome new facts which entailed the modification of he details of Pfluger's hypothesis. Thus, the bringing of the fatty acids into solution in water was considered to be largely due to the hydrotropic action of bile salts rather than soap formation, as originally proposed They also put forward the view that the re-synthesis of triglycerides in the intestinal cell had to pass through an intermediary phospholipid stage, which was controlled by the adrenal cortex These modifications, however, did not affect the essential basis of Pfluger's hypothesis Bloor[3] supported this view of the fat absorption mechanism

Some doubts on the question of the completeness of lipolysis, especially in the cat, were expressed by Mellanby[4] Stimulated by these observations, my colleagues and I carried out a series of experimental studies from 1934 onwards on various aspects of fat absorption Our studies were especially concerned with particulate fat in the blood, the different effects and characteristics of absorption of various fatty acids and glycerides, lipolysis both *in vitro* and *in vivo* and defective fat absorption in human subjects[5–9] This work led us to the conclusion that lipolysis need not be complete before the absorption of glycerides occurred Since no hydrotropic mechanism for glycerides could be demonstrated in the intestinal lumen, this conclusion was incompatible with two of the principal tenets of the lipolytic hypothesis The methods we used were, of necessity, indirect, so that final settlement of this matter had to await studies involving the use of isotope-labelled molecules These studies were eventually carried out by Favarger and his colleagues[10,11], Karnovsky and Gidez[12] and Reiser and his co-workers[13], all of whom substantiated our view that complete lipolysis was not an obligatory step in fat absorption Our observations on the formation of monoglycerides and diglycerides during pancreatic lipolysis were also confirmed and considerably extended by Desnuelle and his group[14,15] and by Mattson *et al* [16] It is now generally accepted by workers in this field that lipolysis in the intestinal lumen is partial and not complete[17] This was the first step towards the modern concept of the fat absorption mechanism

In 1943 it was thought that all lipids were absorbed from the intestinal lumen, molecularly dispersed in water-soluble form Our studies indicated that this was not necessarily the case, and that water-insoluble glycerides were also removed from the lumen of the intestine For many years the fact that paraffins were not normally absorbed from the intestine had been regarded as strong supporting evidence for the lipolytic hypothesis, since these molecules could neither be hydrolysed by lipase nor brought into solution in water Some absorption of paraffin had been reported, however, by earlier workers[18–21] The quantities involved were said to be small, however, and there was no clear link with the fat absorption mechanism in these studies In 1944 we demonstrated the absorption of paraffin administered intraduodenally to rats in finely particulate form[22] Shoshkes, Geyer and Stare[23] obtained substantially similar results In 1951 we reported a new series of experiments[24], which showed that paraffin could be removed from the intestinal lumen in considerable quantity, provided that it was fed in a suitable glyceride vehicle The importance of glyceride appeared to be related to its ability to cause fine emulsification of the glyceride/paraffin mixture The absorption of paraffin in a glyceride vehicle has been confirmed by Bernhard and Scheitlin[25] These and a number of other investigations indicate that fine emulsification in the intestine is an important step in the removal of the water-insoluble fraction from the lumen, quite apart from any facilitating effect the fine dispersion of the oil may have on the rate of lipolysis[17]

From the outset, the work in my laboratories has been dominated by the fact that lipid molecules must be distributed between the oil and water phase in accordance with their partition coefficients On studying the question of removal of lipid molecules from the oil into the water phase—a stage of the fat absorption mechanism that had been strangely neglected—it was soon apparent that there were considerable differences between short-chain and long-chain saturated fatty acids These differences in partition were also reflected in differences in absorption of the corresponding glycerides—the more water-soluble fatty acids disappearing from the chyle, while the more fat-soluble molecules were retained. Some of these differences had been previously reported by other investigators[26–28]. In 1946, discussing the absorption of free fatty acid independently of the glyceride oil phase, I reached the conclusion " . that fat can be absorbed as fatty acid, provided that the cleavage products can be removed into the aqueous phase from the oil/water interface. This appears to be more easily accomplished in the case of butyric acid than the long-chain fatty acids . . It is concluded, therefore, that fat may pass by the portal vein and that this pathway is used when fatty acid is absorbed During th glyceride absorption, it is the short-chain fatty acids which are most likely to be concerned in this mechanism"[29] Five years later the differential distribution of short-chain and long-chain fatty acids between the chyle and portal blood was confirmed by Chaikoff and his group[30,31] These workers were the first to provide direct proof by the use of isotope labelled materials of the passage of fatty acids in the portal blood.

The importance of partition between the oil and water phase as a factor in the differential absorption of fatty acids and glycerides does not appear to have been fully appreciated. Thus, Bloom, Chaikoff Reinhardt, Entenman and Dauben[32] and Bergstrom Borgstrom, Carlsten and Rottenberg[33] appeared to expect long-chain saturated fatty acid (stearic acid and a glyceride oil phase to be absorbed by different pathways It would be anticipated, however, from consideration of the partition hypothesis[6,29] tha there would be no such differentiation and that the lipid-soluble fatty acid would pass in the chyle. This was found to be the case

Oleic acid was used by us in our earlier experiments because it is liquid at body temperature Under the conditions of our experiments, differences were demonstrable during the absorption of olei acid as compared with olive oil Since at that time olive oil was said to be absorbed only in the form o oleic acid and glycerol, this was an additional poin against complete lipolysis It seemed likely tha oleic acid might be found to be intermediate between the saturated long-chain and short-chain fatty acids in its behaviour during absorption. Since our primary objective was achieved and free fatty acids were no normal dietary constituents, we did not pursue the question of oleic acid absorption further However other workers—notably Tidwell[34], Singer, Sporn and Necheles[35], and recently Bergstrom, Blomstrand and Borgstrom[36], using radioactive isotope-labelled olei acid—have done so These investigators found tha under the conditions of their experiments oleic acid behaved similarly to the long-chain saturated fatty acids and was mainly recovered from particulate fa in the chyle They also confirmed the classica observations of Munk and Rosenstein[37] that fatty acids can be esterified in the course of absorption Only in one group of these experiments has the stat of the fatty acid in the intestinal lumen been reported[38], and in this case it was finely emulsified so that oleic acid itself may provide the particulat oil phase In our experiments there was no demonstrable fine emulsification of the oleic acid in th intestinal lumen and no visible emulsified fat in th chyle during the course of the experiment, so tha we could only observe non-particulate absorption The detailed study of the factors affecting oleic acid absorption might prove to be of interest in connexion with abnormal fat absorption The evidence so far available is not incompatible with the partition hypothesis

Thus, the conceptual changes involved in th replacement of the lipolytic hypothesis of Pfluger by the partition hypothesis are as follows

(1) Complete hydrolysis of glycerides to fatty acids nd glycerol is not an obligatory step in the process f fat absorption.

(2) Lipids do not have to be brought into wateroluble form before they can be removed from the mall intestinal lumen

(3) Eventual partition of the lipid molecules etween the oil and the water phase may affect their istribution in the body after absorption.

These three basic tenets have been strongly suported by studies involving the use of isotope-labelled aterials and other techniques that were not available hen the hypothesis was originally formulated The ther available facts about fat absorption—such as he effect of bile salts, the mechanism and significance f intraluminar emulsification, phospholipid formaion, the metabolic activity in the intestinal cells and he differential absorption of lipid-soluble molecules —can be fitted into the general framework of this artition hypothesis.

Pflüger, E , *Pfluger's Arch* , 86, 1 (1901)

Verzár, F , and McDougall, E J , "Absorption from the Intestine" (Chapman and Hall, London, 1936)

Bloor, W R , "Biochemistry of Fatty Acids" (Reinhold Pub Co , New York, 1943)

Mellanby, J , *J Physiol* , 64 P, 5, 33 (1927)

Elkes, J J , Frazer, A C , and Stewart, H C , *J Physiol* , 95 68 (1939)

[5] Frazer, A C , *J Physiol* , 102, 306, 329 (1943) , *Chem Indust* , 27, 379 (1947) , *Arch Sci Physiol* , 2, 15 (1948) , *Brit Med J* , ii, 769 (1949) , *Trans Roy Soc Trop Med Hyg* , 46, 576 (1952)

[7] Frazer, A C , French, J M , and Thompson, M D , *Brit J Radiol* , 22, 123 (1949)

[8] Frazer, A C , and Sammons, H G , *Biochem J* , 39, 122 (1945)

[9] Frazer, A C , and Stewart, H C , *J Physiol* , 90, 18 (1937)

Favarger, P , and Collet, R A , *Helv physiol pharmacol Acta*, 8 C, 15 (1949)

Favarger, P , Collet, R A , and Cherbuliez, E , *Helv chim Acta*, 34, 1641 (1951)

Karnovsky, M L , and Gidez, L I , *Fed Proc* , 10, 205 (1951)

Reiser, R , Bryson, M J , Carr, M J , and Kuiken, K A , *J Biol Chem* , 194, 131 (1952)

Desnuelle, P , Naudet, M , and Rouzier, J , *Biochim Biophys Acta*, 2, 561 (1948)

Desnuelle, P , Naudet, M , and Constantin, M J , *Biochim Biophys Acta*, 5, 561 (1950) , 7, 251 (1951)

Mattson, F H Benedict, J H Martin, J B , and Beck, L W , *J Nutrit* , 48, 335 (1952)

Frazer, A C , Pover, W F R , and Sammons H G , Proc Int Conf on Biochemical Problems of Lipids, 137 (Flemish Roy Acad Sci , Brussels, 1953)

Bradley, H C , and Gasser, H S , *J Biol Chem* , 11, xx (1912)

Channon, H J , and Collinson, G A , *Biochem J* , 23, 676 (1920)

Channon, H J , and Devine, J , *Biochem J* , 18, 467 (1934)

Stetten, de W , jun , *J Biol Chem* , 147, 327 (1943)

Frazer, A C , Schulman, J H , and Stewart, H C , *J Physiol* , 103, 306 (1944)

Shoshkes, M , Geyer, R P , and Stare, F J , *J Lab Clin Med* , 35, 968 (1950)

Daniel, J W , Frazer, A C , French, J M , and Sammons, H G , *J Physiol* , 114, 26 P (1951)

Bernhard, K , and Scheitlin, E , *Helv Physiol Acta*, 10, 54 (1952)

Davis R E , *J Biol Chem* , 88, 67 (1930)

Hughes, R H , and Wimmer, E. J , *J Biol Chem.*, 108, 141 (1935)

Bavetta, L A , and Deuel, H J., *Amer J. Physiol.*, 136, 712 (1942)

Frazer, A C , *Physiol Rev* , 26, 103 (1946)

Bloom, B , Chaikoff, I L , and Reinhardt, W O , *Amer J Physiol* , 166, 451 (1951)

Kiyasu, J Y , Bloom, B , and Chaikoff, I L , *J Biol Chem* , 199, 415 (1952)

Bloom, B , Chaikoff, I L Reinhardt, W O Entenman, C , and Dauben, W G , *J Biol Chem* , 184, 1 (1950)

Bergström, S , Borgström, B , Carlsten, A , and Rottenberg, M , *Acta Chem Scand* , 4, 1142 (1950)

Tidwell, H C , *J Biol Chem* , 182, 405 (1950)

Singer, H , Sporn, J , and Necheles, H , *Science*, 118, 723 (1953)

Bergström, S , Blomstrand, R , and Borgstrom, B , *Biochem J* , 58, 600 (1954)

Munk, J , and Rosenstein, H , *Virchow's Arch path Anat* , 123, 230, 484 (1891)

Frazer A C , Singer, H , Sporn, J , and Necheles, H , *Science*, 120, 39 (1954)

OBITUARIES

Dr. R. C. Wallace

SCOTLAND has given many of her sons to Canada, but few, if any, have contributed as much to Canadian life as Robert Charles Wallace, who died at his home in Kingston, Ontario, on January 28, at the age of seventy-three Recognized for many years as the doyen of Canadian vice-chancellors, he took an active part in the educational, cultural and scientific life of the Dominion. A native of the Orkneys, at the age of twenty-nine, after a university training which included undergraduate and graduate study at Edinburgh, where during 1909–10 he held an 1851 Exhibition Scholarship and was a Carnegie Fellow, a year as a demonstrator at St Andrews, and a period in Gottingen, where he obtained his Ph D , he went to Canada in 1910. He joined the staff of the University of Manitoba as a lecturer in geology, and after two years was made head of the Department of Geology and Mineralogy. During his Manitoba period he was Commissioner of Northern Manitoba during 1918–21 and Commissioner of Mines and Natural Resources for Manitoba during 1926–28. By 1928 the marked gifts he had shown as scientist, writer, speaker, administrator and educational leader led to his appointment in that year as second president of the University of Alberta This post he held until 1936, when he was appointed principal and vice-chancellor of Queen's University, Kingston, Ontario. In this position he remained until his retirement in 1951

While at Alberta and at Queen's, he combined his duties as vice-chancellor with many activities. At various times he was chairman of the Research Council of Alberta , a member of the National Research Council of Canada , chairman of the Ontario Research Commission , president of the Royal Society of Canada, of the Canadian Institute of Mining and Metallurgy, and of the Association of Canadian Clubs He was a Fellow of the Geological Society of America, of the Mineralogy Society of America, and of the Society of Economic Geology. Towards the end of the Second World War he took an active part in the proceedings of a Federal Government Committee which led to the publication of the Wallace report on the conservation and development of Canada's natural resources He played an important part in the founding of Unesco, being one of the original three Canadian delegates. In New York his counsel was sought and welcomed by the Carnegie Corporation

With such a record it is not surprising that he was given honorary degrees by as many as twenty universities, among them his *Alma Mater* Edinburgh, Oxford, the Queen's University, Belfast, and Harvard

After retirement, Wallace continued to be active until within a few months of his death Among other things, he was an executive director of the Arctic Institute of North America, adviser to the Ontario Government on university grants, a member of the Defence Research Board of Canada, and Canadian advisory editor of the "Encyclopaedia Americana"

At Queen's, under his guidance, apart from a big increase in physical assets, such as new buildings, and the founding of such new teaching 'schools' as nursing, industrial relations and local government, there was a marked increase in research in science and in medicine, and in the humanities high scholarship was stimulated In making new appointments, although he insisted on high professional qualifications, he sought also men of character and culture, believing, to quote his own words, that "no teachers can conceal their characters and outlook on life from a class".

Unbending as granite where ethical principles were concerned, Wallace listened gladly to views opposed to his own and was kind to people in all walks of life His office door was open, literally and metaphorically, to members of staff and students alike. Like most Scots, he made no outward display of the sentiment which lay below the surface. But only a few months before his death, on the occasion of the centenary of *The Orcadian,* he wrote with feeling of "scenes of cliff and sea and sky" and of "that indescribably soft ethereal light at or near midnight on summer's longest days in the Orkneys", things which were caught "indelibly in memory".

He is survived by his wife, Elizabeth Smith, also a native of the Orkneys, whose graciousness and natural charm added greatly to the warm welcome given the many who went to the principal's residence on Queen's University grounds. Three daughters, Mrs D E Woodsworth, Mrs H. W. Addington and Mrs Charles Baugh, also survive A son, Ronald, died in 1936 J K ROBERTSON

Mr G W Grabham, O.B.E.

GEORGE WALTER GRABHAM was born in 1882 in Madeira, where his father, Dr Michael Grabham, was a well-known resident. Educated at University College School and at St John's College, Cambridge, he joined the Geological Survey of Great Britain in 1903 and worked in Scotland until 1906 He then followed T. Barron as Government geologist in the Anglo-Egyptian Sudan. There, throughout his service, he travelled widely, on foot and by river, with camels and with both early and modern motor transport He was mainly concerned with the most vital need—water, and in his journeys and special investigations he gathered a unique knowledge of the geology of the country. By far the greater part of his work is represented by unpublished reports in the Geological Survey office in Khartoum. He was also closely interested in the people's agricultural and other pursuits, past and present, and was acting conservator of antiquities.

Outside the Sudan he made extensive journeys, about which little was heard, in inter-tropical Africa, he was best known for his official mission to Lake Tana (with R P. Black, 1920–21)

Grabham retired from the Geological Survey of the Sudan in 1934, but was retained as geological adviser until 1939. After the Second World War he wintered in the Sudan, maintaining vigorously his many and varied personal interests

In Madeira he inherited his father's house, where his affection for the island, and all that it implied for him, was widely known To the end he made exacting walks in that land of profound cliffs and gorges Here, as in the Sudan, he took unflagging pleasure in showing others the country, either on the ground or with the aid of his vast collection of photographs and lantern slides, his hospitality was proverbial

He was a familiar figure at international geological congresses, and on their long field excursions, in many parts of the world, and for many years hi annual visit to Britain coincided with the meeting o the British Association, at which he enjoyed meetin his friends, latterly he came to his clubs in Londo twice a year, and made a tour of his diminishin circle of relatives and close associates

To many, Grabham seemed a lonely man, but h delighted in company, a rather forbidding figure but he had an inexhaustible fund of humour, of hi sympathy and kindness the sum will never be tol His end was as he would probably have wished, h was about to lecture to a cultural meeting in Kha toum, but, feeling unwell, took his leave and bicycle home to his house in Burri Village, where he wa found dead the following morning. So passes great figure. K S. SANDFORD

Dr W. M Ware

FORMER colleagues have experienced a deep sens of loss following the sudden death, on February 1 of William Melville Ware at the age of sixty-tw Particularly has the loss been felt by many prese and past members of Wye College (University London), for it was there that all his scientific wor was done.

Ware entered Wye College in 1911 as a studen after receiving a grounding in the classics at Dov College, followed by a period in an academy at I Havre, where he attained fluency in French. Durin the First World War he was on active service wit the Army and on demobilization returned to Wye as lecturer in botany. Research, however, was his *métie* while still a lecturer he investigated problems clover with a grant from the Ministry of Agricultur and this led to the publication of several papers on th subject and on certain diseases of other plants

In 1923 he accepted an invitation to join th Mycology Department (Research and Advisor under the direction of Prof. E. S Salmon. For th next twenty-three years his investigations formed major stimulus to the growth of the young science plant pathology

His main researches were on diseases of fruit, ho and mushrooms, but other horticultural and agr cultural crops also received attention, and about hundred original papers of high quality appear under his name, either alone or jointly with colleague His researches into apple scab (*Venturia inaequal* (Cooke) Wint) and hop downy mildew (*Pseud peronospora humuli* (Miyabe and Tak) G. W. Wilso are particularly outstanding, while his observatio on the cultivated mushroom led not only to t discovery of crop-reducing diseases, but also to t writing of a bulletin on mushroom-growing for t Ministry of Agriculture. Following his first degree B Sc. (Agric), he was awarded the M Sc in 1923 a the D.Sc in 1935.

Ware followed Prof Salmon as head of t Mycology Department at Wye in 1937, and direct research and advisory work through the difficult w years, but the decision to absorb the Departme into the Civil Service prompted his retirement October 1946.

Ware served on the Council of the Association Applied Biologists and as a member of the Pla Pathology Committee of the British Mycologic Society; but his distaste for committee wo debarred him from seeking office in the learn societies His contributions to science are familiar plant pathologists throughout the world and, had his ambition equalled his ability, high academic rewards would undoubtedly have been his.

In retirement, gardening and travel were among his chief delights, but since 1948, as assistant editor of the *Journal of Horticultural Science*, he had kept in touch with current research.

Although modest and reserved to an unusual degree, Ware's attractive personality brought him a wide circle of friends, and many of those who knew him best have reason to be grateful for his help and for his counsel, which was sought by his seniors as well as by his juniors. He leaves a widow.

H. H. GLASSCOCK

NEWS and VIEWS

Research in the Physics of Solids

Prof. A. H. Cottrell

PROF. A. H. COTTRELL, of the Department of Physical Metallurgy, University of Birmingham, has accepted an appointment with the U.K. Atomic Energy Authority, at the Atomic Energy Research Establishment, Harwell, as deputy head of the Metallurgy Division and leader of a group engaged in research on the physics of solids. He will be taking up his new appointment in April. Prof. Cottrell, who is thirty-five, is a graduate of the University of Birmingham. During 1939–45 he was engaged in research on the welding of tank armour. He was appointed a lecturer in metallurgy in the University of Birmingham in 1943. When the late Prof. Hanson, immediately after the War, was re-organizing teaching and research in metallurgy at Birmingham, one of his principal objects was to create a strong school of theoretical and physical metallurgy. The Department of Scientific and Industrial Research gave substantial support for an initial period, and with notable vision Prof. Hanson recommended the University to create two new professorships, one in physical metallurgy and the other in metal physics. Accordingly, in 1949 Dr. Cottrell and Dr. G. V. Raynor, then reader in theoretical metallurgy, were appointed to the new chairs. On the death of Prof. Hanson in 1953, Profs. Cottrell and Raynor were made joint heads of the Department of Physical Metallurgy.

Prof. Cottrell's researches have been mainly concerned with the plastic deformation of metal crystals. In ample justification of Prof. Hanson's hopes, he and the group of able young men whom he has gathered around him have done much to establish Britain's leading position in this field of research. Prof. Cottrell has travelled extensively—he made lecture tours in the United States in 1950 and 1953 and was guest lecturer at the University of the Witwatersrand in 1952 and at the University of Louvain in 1953. He attended the Ninth International Solvay Conference on Physics at Brussels in 1951, and delivered the 1953 R. S. Williams Lectures at the Massachusetts Institute of Technology. He was awarded the Rosenhain Medal by the Institute of Metals in 1954. Prof. Cottrell has acted as chairman of the Basic Properties Committee of the Inter-Service Metallurgical Research Council, and is also associate editor for Great Britain of *Acta Metallurgica*.

Psychology at Glasgow : Prof. R. W. Pickford

PROF. RALPH WILLIAM PICKFORD, who has been appointed to be the first incumbent of the recently created chair of psychology in the University of Glasgow, has been associated with the Department of Psychology at Glasgow for more than twenty-five years. His first appointment there was in 1930 as assistant to Dr. R. H. Thouless, becoming lecturer in 1935 and senior lecturer and head of the Department in 1948. Dr. Pickford was a student at the then Southampton University College before proceeding in 1923 to Emmanuel College, Cambridge, where he graduated in psychology and obtained his Ph.D. in 1932. During 1927–32, with a grant from the Vision Committee of the Medical Research Council, Prof. Pickford undertook research on the psychology of reading. His publications include a monograph, two books, and many papers and articles dealing especially with experimental studies of colour vision and visual perception, and with the psychology of art and social and clinical psychology. He has been president and is retiring secretary of the Scottish Branch of the British Psychological Society, and was a founder member and the first president of the Experimental Psychology Group. For ten years he has worked in a voluntary capacity at the Notre Dame Child Guidance Clinic, at the Davidson Clinic, Glasgow, and as a counsellor for the Glasgow Marriage Guidance Council. He is keenly interested in music.

Sir George Beilby Memorial Awards, 1954

THE administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have made awards from the Fund for 1954, each of one hundred and fifty guineas, to Dr. H. K. Hardy and to Dr. J. W. Menter. The awards are made to British investigators for work in such fields as fuel economy, chemical engineering and metallurgy, in which Sir George Beilby's special interests lay, and in general they are given to relatively young scientists for work over a period of years.

Dr. H. K. Hardy's award is for work in physical metallurgy, with special reference to precipitation hardening and to the thermodynamics of phase equilibria in alloy systems. He graduated in metallurgy from the Imperial College of Science and Technology, London, in 1940, and afterwards, while at the Research Department of the Northern Aluminium Co., Ltd., and at Aluminium Laboratories, Ltd., he was concerned with the metallography of duralumin-type alloys and the development of high-strength aluminium–zinc–magnesium alloys, particularly the nature of the extrusion process and the microstructural effects associated with the onset of overheating. In 1946 he joined the Fulmer Research Institute as head of the Physical Metallurgy Section and later as senior metallurgist, where he investigated the precipitation process in aluminium–copper alloys over a wide range of supersaturations and with the addition of small quantities of other elements. The thermodynamics of this and other phase equilibria in alloy systems have been closely studied.

Dr. J. W. Menter entered Peterhouse, Cambridge, and after governmental war-time service graduated in physics in 1945. His Beilby award is for work on surface phenomena, with special reference to the application of electron optical techniques to the elucidation of a wide range of problems , and this work commenced at Cambridge in the Research Laboratory for the Physics and Chemistry of Surfaces. Department of Physical Chemistry, with a study by electron diffraction of the orientation of long-chain hydrocarbon compounds on metal surfaces. He has applied electron optical techniques to metallurgical problems, and more recently he has adapted a transmission electron microscope for use as a reflexion instrument and investigated a wide range of surface phenomena. Dr. Menter is at present working in the Tube Investments Research Laboratories, Hinxton Hall

Royal Society of Edinburgh . New Fellows

The following have been elected Fellows of the Royal Society of Edinburgh Mr W. Anderson, district geologist, Geological Survey of Great Britain , Dr. D J Bell, senior principal scientific officer, Poultry Research Centre, Edinburgh , Dr. W. A P. Black, head of the Chemical Division of the Institute of Seaweed Research, Musselburgh , Dr. P H Davis, lecturer in the Department of Botany, University of Edinburgh , Dr W. A. Fairbairn, lecturer in the Department of Forestry, University of Edinburgh , Dr. D J Finney, reader in statistics, University of Aberdeen , Dr. P. G. Fothergill, lecturer in botany, University of Durham , Principal T. M Knox, University of St Andrews , Mr. J. Kyles, lecturer in the Department of Natural Philosophy, University of Edinburgh , Prof A. M Macbeath, Department of Mathematics, Queen's College, Dundee , Mr D. H. McIntosh, superintendent of the Observatory, Eskdalemuir, Dumfriesshire , Sir James Miller, managing director of James Miller and Partners, Ltd. , Dr. N. Miller, senior lecturer in radiochemistry, University of Edinburgh , Dr. G. H Mitchell, district geologist, Geological Survey of Great Britain (Edinburgh Office) , Dr R L Mitchell, head of the Department of Spectrochemistry, Macaulay Institute for Soil Research, Aberdeen , Prof S. D Nisbet, Department of Education, University of Glasgow , Dr A E. Oxford, head of the Department of Microbiology, Rowett Research Institute, Aberdeen , Dr H. S A Potter, senior lecturer in the Department of Mathematics, University of Aberdeen , Mr K. A. Pyefinch, Brown Trout Research Laboratory, Pitlochry , Prof R. A Rankin, Department of Mathematics, University of Glasgow , Dr. G. A. Reay, superintendent of the Torry Research Station, Aberdeen , Prof. G J Romanes, Department of Anatomy, University of Edinburgh , Prof. A. B. Stewart, Department of Agriculture, University of Aberdeen , Mr. H. B Sutherland, senior lecturer in civil engineering, University of Glasgow , and Dr D Taylor, lecturer in chemistry, University of Edinburgh.

C. V. Boys (1855–1944). Centenary Exhibition in London

The Science Museum, London, is commemorating the centenary of the birth of Sir Charles Vernon Boys (1855–1944) by a special display of instruments drawn from the permanent collections. The exhibition will be open for a period of three months, commencing on March 15, Boys's birthday. Of his manifold activities in the field of experimental physics, Boys is probably best remembered for his work on the production and properties of exceedingly fine quartz fibres. The fibres were used in the construction of a very sensitive radio-micrometer which, aided by a reflecting telescope, was capable of detecting radiation as feeble as that from the flame of a candle at a distance of almost three miles The elastic properties of quartz fibres were also utilized by Boys in designing a torsion balance with which he determined the Newtonian constant of gravitation and the mean density of the earth with an accuracy previously unattainable In addition to the original radio-micrometer and gravitational apparatus, the exhibits include Boys's lightning camera, his gas calorimeter and a number of mathematical instruments.

Optimum Use of Scientific Workers in Great Britain

In announcing in the House of Commons on March 10 the Government's acceptance of the recommendations of the Burnham Committee for the payment of special allowances to teachers of advanced work, Sir David Eccles, the Minister of Education, said that at the request of the Government the Federation of British Industries has sent a circular to the seven thousand individual firms and three hundred trade associations comprising its membership asking them to exercise restraint in bidding against the schools for science graduates. The circular states that, in discussions with the Government on the shortage of science teachers, it was pointed out to the Federation that a hopeless situation would arise if the increased remuneration for teachers was countered by a corresponding raising of salary levels by industry. The Federation agreed to put this point to its members, and the circular suggests that in this connexion firms could also review the use they make of scientific staff so as to reserve such staf for the really essential work for which they are best fitted. It is suggested that, in addition, some relief could be obtained by retaining scientific staf beyond the normal retiring age and that, if firms could help to encourage greater numbers of suitable and able boys to remain at school for a further period both industry and the schools would ultimately benefit from an increased number of science graduates The circular also states that the Government i reviewing the whole question of scientific workers in the public service so as to ensure that the best and most economical use is made of them in the nationa interest.

Chalk Lime and Allied Industries' Research Association

The first general meeting of the Chalk Lime and Allied Industries' Research Association was held on March 9 in the Association's offices at Hanove House, 73–78 High Holborn, London. The preliminary work leading to the establishment of this the latest of the research associations to be formed under the ægis of the Department of Scientific and Industrial Research, was done by the members o the Southern Lime Association As indicated by it title, the new Association will conduct co-operativ research for the chalk lime and allied industries A the meeting, Mr W. L Clarke was elected chairma of the Association and Mr M. W Hall as vice chairman. Mr. G. E. Bessey has been appointe director of research and has already taken up hi appointment Mr. Bessey was previously director o research of the Research Council of the Britis Whiting Federation and before 1949 was on the sta of the Building Research Station. Negotiations ar at present in progress for a site for laboratories and for temporary accommodation until new laboratories can be built.

University of London

THE following appointments have been made in the University of London: Prof. L. J. Kastner, professor of engineering and head of the Engineering Department, University College, Swansea, to the University chair of mechanical engineering tenable at King's College; Dr. E. A. Wright, experimental pathologist at the Medical Research Council's Experimental Radiopathology Research Unit, Hammersmith Hospital, to the University readership in pathology tenable at St. Mary's Hospital Medical School. The title of reader in electrical engineering in the University of London has been conferred on Dr. A. L. Cullen in respect of his post at University College, and that of reader in mathematics in the University of London on Dr. Winifred L. C. Sargent in respect of her post at Bedford College.

Postgraduate Awards in Agricultural Research

THE Agricultural Research Council has recently ssued a useful booklet giving details of the training rants, research studentships and fellowships which he Council is offering this year. The booklet also gives information about the openings in the agri-ultural research and advisory services. Two veterinary research fellowships of £850 a year plus uperannuation, and tenable for three years, will be open to workers holding a veterinary qualification who have had not less than three years of experience in veterinary research; and three junior agricultural esearch fellowships of £630 a year plus supernnuation, and also tenable for three years, will be pen to honours graduates with not less than three years of postgraduate experience. In addition, the Council is again offering up to thirty postgraduate raining grants and research studentships in agri-ultural and veterinary science, applications for which hould reach the Council by March 31. A copy of he booklet, free of charge, and further information an be obtained from the Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1.

Efficiency of the Individual Worker: Conference in Cambridge

A RESIDENTIAL conference, to be held in Cambridge during March 31–April 3, has been arranged by the Medical Research Council with the object of discussing the latest results of research directed to mproving the efficiency of the individual worker. Sir Geoffrey Vickers will take the chair, and about a hundred and fifty delegates from industry and esearch establishments are expected. The subjects o be discussed will include the effects of environment on working capacity, the design of machinery in elation to the operator, the effects of continued or prolonged work on individual efficiency, industrial raining problems, and the use which is made of esearch results. In addition, there will be a short film, followed by a discussion, showing the way in which psychological processes and principles have elevance in daily life and industrial production. Practical demonstrations, including working models illustrating the research work which has been carried out, will also be shown. Further information can be obtained from the Medical Research Council, 38 Old Queen Street, London, S.W.1.

Announcements

THE following Royal Society Lectures will be given this year: Croonian Lecture on June 16, by Prof. C. H. Best (University of Toronto), speaking on dietary factors in the protection of the liver, kidneys, heart and other organs in experimental animals—the lipotropic agents; and Bakerian Lecture on April 28, by Prof. M. L. E. Oliphant (Australian National University, Canberra), speaking on the acceleration of charged particles to very high energies.

THE Medical Research Council is offering four Eli Lilly travelling fellowships and one Lederle travelling fellowship for work in the United States during the academic year 1955–56. The fellowships, which are worth 2,700 dollars (3,900 for a married man), are for graduates resident in Great Britain trained in research work in clinical medicine or surgery or some other branch of medical science. Application forms, to be returned by March 28, and further information can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

THE annual conference of the Oil and Colour Chemists' Association will be held this year in Llandudno during June 7–11, and the subject for discussion will be "Film Structure and Adhesion". The conference is open to non-members. Registration forms, to be returned by April 1, and further information can be obtained from the general secretary, R. H. Hamblin, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

THE spring meeting of the Optical Society of America will be held in the Hotel Statler, New York City, during April 7–9, and will include a special symposium on optical molecular spectroscopy. On April 8 the Edgar D. Tillyer Medal of the Society will be presented to Prof. Adelbert Ames, jun. The meeting will be open to non-members of the Society. Further information can be obtained from the secretary of the Society, Arthur C. Hardy, Massachusetts Institute of Technology, Cambridge 39, Mass.

A CONFERENCE on starch, organized by the Arbeitsgemeinschaft Getreideforschung in conjunction with the Fachverband der Stärkeindustrie, will be held in Detmold, Germany, at the Roemer-Haus of the former organization during April 26–28. The programme will be in four parts—fundamental research, research methods, starch production and techniques, and starch derivatives. Of the twenty-two speakers, fourteen will be from outside Germany. Further information can be obtained from the Arbeitsgemeinschaft Getreideforschung e.V., Am Schützenberg 9, Detmold.

THE Association of Agriculture (52 Victoria Street, London, S.W.1) is arranging a course on "World Food: an Illustrated Study in Biology and Geography", to be held in Westham House Adult Residential College, Westham House, Barford, Warwick, during May 27–31. The fee for the course, which is fully residential, is £3 12*s*. 6*d*. Application should be made to Captain Frank Owen at Westham House.

THE annual general meeting of "Science for Peace", followed by a public conference on "Nuclear Explosions—their Long-term Effects", will be held in the Holborn Assembly Hall, John's Mews, London, W.C.1, on March 26. Further information can be obtained from the Honorary Secretary, Science for Peace, 16 Ulster Place, London, W.C.1.

BIRKENHEAD TECHNICAL COLLEGE

THE foundation stone of the new Technical College at Birkenhead was laid on May 3, 1950, by Her Majesty the Queen, now Queen Elizabeth the Queen Mother, and the College was opened officially on January 8 last by Sir Henry Cohen, a former student of Birkenhead schools who has reached eminence in his chosen profession of medicine.

The building is in the form of a letter H, one limb of which is six stories high and includes the classrooms, drawing offices, library, administrative offices, and staff and student common rooms. The limb at right angles to this is termed the 'Spine Block' and is of five stories housing the electrical engineering and science laboratories and domestic craft rooms, and the top floor is devoted to the College refectory and kitchen. The other limb, parallel to the classroom block, forms the workshop block, which is a single-story structure.

The building is steel-framed, encased in concrete with pre-cast concrete floors. It is faced with wire-cut bricks with the exception of the centre of the front, which is faced with Westmorland rough-hewn slate. The building is in three sections with expansion joints. Gauges have been fitted to show the seasonal movement. The total floor area of the College is approximately 250,000 sq. ft.

At the north end of the classroom block is the hall, which will seat approximately 1,000 and is fully equipped for theatrical purposes and can be separated from the main building for use by outside cultural organizations. There is also a gymnasium.

The College is organized in the following departments: building, commerce, domestic science, electrical engineering, mechanical engineering and science.

The building was opened for instructional purpose in September 1954, and the enrolments at the momen are more than 3,600, of whom approximately 20 are full-time, 1,100 day-release, and 2,300 evenin students.

The various departments are offering a wide rang of courses, including national certificate, highe national certificate and craft courses. Thus in th Department of Building, in addition to ordinar national certificates in building, there are City an Guilds courses in brickwork, carpentry and joinery plumbing and ships' plumbing. The Department o Commerce provides courses for national certificate in commerce, secretarial and commercial courses intermediate and final examination courses for th various professional institutions. Ordinary and highe national certificate courses, together with City an Guilds courses in electrical installation, telecommunications and radio servicing, are offered in th Department of Electrical Engineering. In th Department of Mechanical Engineering there ar courses for ordinary national diploma in mechanica engineering for seagoing engineers, ordinary an higher national certificates in mechanical engineerin with endorsement subjects, ordinary and highe national certificates in naval architecture, togethe with craft courses in workshop practice, moto vehicle mechanics' work, sheet and plate metal work welding, and foundry practice. In the Department o Science there are courses for ordinary and highe national certificates in chemistry, an intensive full time course for, and part-time courses leading to the examination for the associateship of the Roya Institute of Chemistry, a full-time intermediat

Birkenhead Technical College

pharmacy course, and a number of short courses on glass-working, instrument technology, etc , and an ordinary national certificate course in metallurgy

The College is also recognized for the award of the higher national certificate in chemical engineering.

The Domestic Studies Department covers a wide range of examination courses leading to the award of the City and Guilds or Union of Lancashire and Cheshire Institutes' certificates in cookery, dress-making, needlework, tailoring, upholstery, and the Educational Development Association certificates in basketry Bakery courses were started in September in preparation for the City and Guilds intermediate examination in bread-making and flour confectionery. Catering courses include the catering trades basic training course (City and Guilds), cookery for hotels and restaurants (City and Guilds), and catering for non-residential licensed houses

The total accommodation in the College, apart from the administrative offices, consists of forty-two classrooms, five lecture theatres, sixteen laboratories, three commerce rooms, geography room, three domestic study rooms, three craft rooms, ten workshops, a bakery and a butchery.

The first principal of the College, Mr C V. Vinten Fenton, has a staff of forty-two full-time and two hundred part-time teachers. Mr Fenton, before going to Birkenhead, was the first principal of the Peterborough College , there he was responsible for organizing technical education and saw the completion of the first phase of the new technical college built in that city.

ASLIB SCOTTISH BRANCH

ANNUAL MEETING

THE annual general meeting and one-day conference of the Scottish Branch of Aslib (Associaion of Special Libraries and Information Bureaux) was held in the Mitchell Library, Glasgow, on February 11 The first paper of the morning was given by Dr. B J A Bard, industrial manager of he National Research Development Corporation. He spoke of the work of the Corporation since its nception in 1950 and described its function as the development and exploitation, in the public interest, f inventions resulting from research carried out by overnment departments and other public bodies, nd private inventions where they are of primary mportance to the public interest Dr Bard outlined he organization of the Corporation, described how nventions are exploited and developed, and gave a eneral description of some of the projects in hand

Following this paper, there was a symposium on he treatment and circulation of periodicals. The rst speaker was Miss E Handlen, librarian of the Department of the Secretary of State for Scotland. he said that, whatever the scope of a library, two emands are common to all users want to see rticles as soon as they are published, and they want to go to the library and find articles to help with a roblem Dealing with up to two thousand titles received by the Department of the Secretary of State for Scotland, these are sorted and the date of arrival recorded, and they are then circulated according to mple circulation slips made up so that the most senior officers have priority.

In this way, periodicals are circulated around seven undred chosen users, although this figure should be trebled because officers on the lists show important articles to their juniors All, or nearly all, periodicals are brought back to the Library, preferably before a new issue arrives. To help in this circulation, the Library has specially printed cards arranged alphabetically in a tumble-card cabinet with spaces on the face for the date entries, and other more permanent information on the back (the circulation, start of run, binding, etc) This permits 'flagging' any item which needs special attention. One man can handle the work. It sometimes happens that a periodical circulated to medical men may contain an article of value to, say, a sanitary engineer The supplementary service for these fits into the general circulation scheme , the first name on circulation lists is that of the librarian, and Miss Handlen includes the odd articles in the accessions lists, so that officers who have missed circulations can borrow Such cases amount to less than ten in one month. There may be about the same number of important articles meriting inclusion in the subject card-index.

Miss Handlen favours duplication of purchase in the case of periodicals of ephemeral interest, since this permits retention of one master set and cutting of the other copies, thus saving time and labour in copying She emphasized that circulation of periodicals is necessary where there are 700 users and 29,000 issues, and that display and retention in the library would be quite impracticable Even in a smaller library, the display system would lead to loans, and loans are not as quick as circulations and are more costly in staff time. Full indexing of articles is not possible, and Miss Handlen said that full indexing often seems to defeat its own ends, being extremely cumbersome and costly for small results Finally, she asked if there is not a danger of a librarian coming too much between the user and the holdings She felt that librarianship is in danger of becoming an esoteric clerical job if too much is attempted in the way of carding every reference Miss Handlen said that she would rather contribute £25 a year to an abstracting journal to help it become more efficient and up to date in publication than pay £500 to an extra assistant to anticipate the abstracts.

The second speaker in the symposium was Mr. A Liddle, librarian to the firm of Babcock and Wilcox, Ltd , who described the controlled circulation of a hundred and forty periodical titles to approximately a hundred and twenty readers, most of whom are within the firm's research station The circulation slips affixed to the periodical have columns for name, department, see pages, date sent, returned and initials A section is provided for readers to note that they wish pages to be abstracted and indexed in the central file. Normally, periodicals are displayed for seven days so that anyone can add their name to the circulation list, or delete it if it is already there and that issue is not of further interest Mr Liddle thought that the time necessary for recording is justifiable by results and described the visible card system used To help in the service of getting information to users as quickly as possible, the periodicals are first scanned and items of current interest are abstracted and produced in the form of a weekly bulletin

The third speaker in the symposium was Mr J. R K Pirie, librarian of the Mechanical Engineering Research Laboratory, East Kilbride, of the Department of Scientific and Industrial Research. He outlined the difficulty of circulating three hundred and fifty periodicals to staff housed in several buildings, one set being more than four miles from the main central library. The staff have been asked which periodicals they wish to see, and only nineteen were asked for by more than eight readers; circulation lists were then drawn up. Periodicals are normally displayed for seven days, allowing members of staff to scan and delete their names from the lists if there is nothing of interest. Circulation priority is arranged into the categories of 'urgent', 'personal' and 'departmental'. The system of recording is that described by its designer, Miss Ruth Jacobs (then of the Department of Scientific and Industrial Research), in the *Journal of Documentation*, 6 (4), 213 (1950). Names of borrowers are grouped, so that periodicals are returned to the library after every three or four names for checking.

The afternoon session was devoted to a paper by Mr. F. W. Gravell, librarian of the Patent Office. He spoke of the purpose and process of patenting an invention, and described the scope and work of the Patent Office Library. The full text of the papers by Dr. Bard and Mr. Gravell will be published in *Aslib Proceedings* in due course. MARGARET SPENCE

LINEN INDUSTRY RESEARCH ASSOCIATION

AT the thirty-fifth annual general meeting of the Linen Industry Research Association on December 17, 1954, both the chairman, Mr. H. B. McCance, and Mr. N. V. Cooke, in proposing and seconding the motion to adopt the report of the council and the accounts, stressed the importance of making sure that the industry gets the best value for the expenditure of £70,000 a year on research. Mr. McCance urged that research should be concentrated on a few well-defined objectives of such importance that the industry would at once provide the whole of the money required if the government contribution were withdrawn. Mr. Cooke emphasized the importance of securing staff of outstanding ability and especially with imagination, at least some of whom should come from outside the industry. This point was welcomed by the director of research, Dr. A. J. Turner, who also stressed the value of those of the staff who had been appointed for their technical knowledge and experience. Most of the present staff had come to the Association with no previous knowledge of textiles; but the Association is still trying to obtain one or two more senior men of the type Mr. Cooke considers necessary.

In reviewing the year's work Dr. Turner said that we are in the throes of a new industrial revolution arising out of the modern advances in physics and chemistry. In so far as the linen industry is still a craft industry, a great struggle is involved in trying to prevent it from shrinking further in competition with the man-made fibres. It will be necessary to attempt to process specially selected man-made fibres on flax machinery to obtain special effects and novelties. The linen industry of the future can be transformed so as to include the man-made staple fibres, and unique blends of such fibres with one another or with flax can be made into new and readily saleable cloths. Little work is at present being done by the Association on flax production. In the spinning departments the most interesting fundamental research is that on yarn irregularity. Dr. Turner also referred to the value of starch ethers and cellulose ethers as sizing agents for linen yarns; but the advances in polymer chemistry have been most keenly felt in the chemistry department, particularly as regards special proofing finishes, and the possibilities are far from being exhausted.

The report of the Council of the Linen Industry Research Association for the year ended September 30, 1954*, records a slight fall in membership, from 285 to 281, and regrets also the decision by the Government to terminate, on economic grounds, the Home Flax Production Scheme. There has also been a large contraction in the flax acreage in Northern Ireland, where tank retting has almost ceased, and in consequence research work on tank retting problems has been suspended. Research work on spinning has resulted in mechanical modifications for improving the operation of drawing frames and in recommendations for improving the control of yarn quality and the efficiency. A new system has been developed for controlling the levelness of drafting, and the study of the strength relation of yarns and cloths has enabled the necessary yarn strengths to be predicted when making cloths of certain specification. A new test has been devised for measuring the absorbency of cloth during the first few seconds of contact with a wet surface, and promising results have been obtained in factory trials with some new sizing materials. A prototype production model of the new spool winder, which makes packages suitable for overend unwinding, is now being built; much attention has been given to proofing linen fabrics, and improvements have been made in waterproofing flax canvases with pigmented drying oils and with oils and waxes applied from emulsions.

---

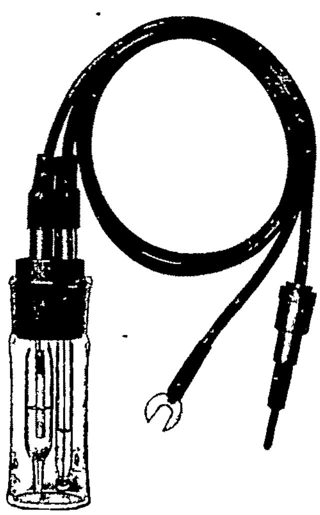
* Linen Industry Research Association. Report of the Council, 1954. Pp. 20. (Belfast: Linen Industry Research Association, 1954.)

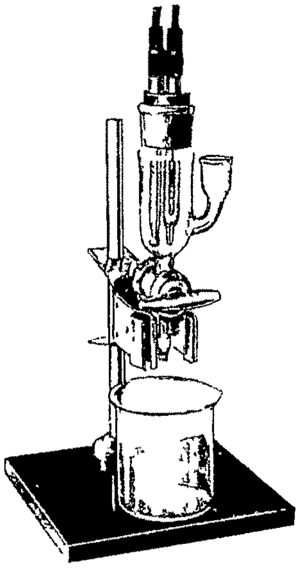
APPARENT HETEROGENEITY OF DEOXYRIBONUCLEIC ACID: SEDIMENTATION EXPERIMENTS AT LOW CONCENTRATIONS

By DR. K. V. SHOOTER and PROF. J. A. V. BUTLER

Chester Beatty Research Institute, Institute of Cancer Research: Royal Cancer Hospital, Fulham Road, London, S.W.3

SEDIMENTATION experiments with deoxyribonucleic acid, using the Philpot–Svensson[1] optical system, can be carried out at concentrations down to 5×10^{-4} gm./ml. Although at this concentration only a slight spreading of the peak is observed[2], this cannot be taken as an indication of the homogeneity of the material, since it is known from light-scattering measurements[3] that interaction between the molecules only becomes small at concentrations less than 3×10^{-5} gm./ml. The strong absorption in the ultra-violet shown by solutions of deoxyribonucleic acid can be used to measure the rate of sedimentation at concentrations down to 10^{-5} gm./ml. The results discussed in this communication refer to various dilutions of three different stock solutions prepared from one preparation (DNA7)[4]. 0·02–0·04 per cent of deoxyribonucleic acid was dissolved in water for twenty-four hours and then diluted with an equal volume of 0·4 *M* sodium chloride. These solutions





DORAN

pH ELECTRODES

The Dual Alkacid electrode as illustrated on the left has been adopted almost universally as a convenient, reliable and robust unit. The Micro Alkacid electrode used in conjunction with the Micro Calomel Element covers a range of 0–13 pH and is linear to within ± 0·01 pH unit These electrodes are mounted in a bakelite stopper which fits a C24 ground glass socket and they are strictly interchangeable For convenience the Electrode Vessel shown on the right, or a similar vessel arranged for continuous flowing solutions, may be used with the same Micro Electrode Assembly. A third hole in the bakelite stopper permits the use of a thermometer or the temperature compensator element supplied with the Doran Universal pH Meter. These and other electrodes are illustrated and described in our List 117, a copy of which will gladly be sent on request

DORAN INSTRUMENT CO., LTD.
STROUD, GLOS.

Telephone :
STROUD 462
and 15

LEARNED
JOURNALS
BOUGHT

STECHERT-HAFNER INC.
The World's Leading International Booksellers

New York Paris : Stuttgart
London Star Yard, Carey Street, W C 2

ie SCIENTIFIC BOOK SUPPLY SERVICE
(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE: CEN 1294

FETTER LANE, FLEET STREET, LONDON, E.C.4

Just Published: Volume 17

ANNUAL REVIEW OF
PHYSIOLOGY

Contributors — Approx 550 pages

F C Mann
W S Wilde
J Needham
A B Hertzman
H Rahn
F R Steggerda
K Matthes
D E. Gregg
H J Vonk
D R Drury
F Crescetelli
J H Burn
D B Lindsley
E N Willmer
S B Barker
W O Nelson
E Zeuthen

B L Baker and G. D. Abrams
R B Livingston and R. Hernández-Peón
W W Swingle and W. Kleinberg
C H. Best, R E Haist, and G. Wrenshall

$7 00 postpaid (U S A), $7 50 postpaid (elsewhere)

ANNUAL REVIEWS, INC.

STANFORD, CALIFORNIA, U S A , H K. LEWIS & CO , LTD , 136, GOWER STREET, LONDON, W C 1, ENGLAND , MARUZEN CO , LTD , 6, TORI-NICHOME NIHONBASHI, TOKYO, JAPAN

Abraham Wald

Selected Papers in Probability and Statistics

Born in Rumania in 1902, Wald studied mathematics at the University of Vienna In 1938 he emigrated to the United States as Fellow of the Cowles Commission for Research in Economics. In the following autumn he went to Columbia University to study modern statistical inference under Hotelling; there he was appointed Professor of Economics in 1944.

The present volume endeavours to place his career in its proper perspective Beginning with a brief biographical sketch, it presents a collection of most of his work —his papers on Decision Function Theory; Probability, Research in Nonparametric Inference; The Neyman-Pearson System of Statistical Inference; The Theory of Regression and Analysis of Variance. Wald's different papers are inter-related to each other, and to the work of others They therefore provide a survey of the wide range of areas in which he made original contributions.

10 × 7 inches 711 pages 60/-

Edited for the Institute of Mathematical Statistics :

T W. Anderson
H. Cramer
H. A. Freeman
J. L. Hodges, Jnr.
E. L Lehman
A. M. Mood
C. M. Stein

Obtainable shortly from your Bookseller

McGRAW-HILL LONDON

Degradation of Vinyl Polymers

By H H G JELLINEK
University of Adelaide, South Australia

(Volume III of PHYSICAL CHEMISTRY · A Series of Monographs
Edited by Eric Hutchinson)

January 1955
329 pp , illus , 68s.

The present book is written mainly from the standpoint of reaction kinetics. The fundamental aspects of the kinetics of degradation are considered in detail. The first chapter, which presents a discussion of formal kinetic theories of degradation, not only has a bearing on vinyl polymers, but also should be of wider interest. The second chapter deals with experimental data on the bulk degradation *in vacuo* Not only are these data discussed on the basis of the formal kinetic theories, but possible actual mechanisms are also considered. Experimental data and theories of degradation in solution and under the influence of oxygen, catalysts, and various chemicals are treated in the third chapter Mechanical degradation and degradation by ultrasonic waves are considered in the last chapter The importance of cavitation for the latter type of degradation is discussed Most recent developments, such as degradation by high energy radiation (x-rays, γ-rays, nuclear pile radiation) are discussed in an appendix.

CONTENTS :

Formal Mathematical Theories of Degradation
Bulk Degradation *in Vacuo*
Degradation in Solution and Oxidative Degradation
Mechanical and Ultrasonic Degradation
Appendix
Author Index—Subject Index.

Physical Chemistry brochure available on request

Academic Press Inc.
New York 10, N.Y., U.S.A.

British Office: **ACADEMIC BOOKS LTD.,**
129 Queensway, London, W.2

MACMILLAN BOOKS

A Text-book of Electricity and Magnetism

G. R. NOAKES, M.A., F.Inst P.

This is the new, Third Edition of a book which will meet the need of those taking Intermediate degree courses and the Advanced and Scholarship Examinations of the General Certificate of Education. All the usual topics required at this stage are dealt with, and where necessary calculus is used Among the special topics discussed are the conduction of electricity through gases, atomic physics and modern views on ferro- and terrestrial magnetism. *Third Edition.* 14*s.*

Advanced Level Examples in Physics

R. V. JOHNS, M A., B Sc.

Lecturer in Physics and Mathematics, City of Liverpool College of Technology

W. F WARE, B Sc., A Inst P.

Senior Physics Master, Cathays High School for Boys, Cardiff

This book of numerical examples is designed to supplement the theoretical and laboratory work of students preparing for examinations in Physics at the Advanced level of the General Certificate of Education and for Intermediate Degree examinations. Some 1,000 examples have been arranged by topics and carefully graded in difficulty Contents are arranged under the headings Mechanics and Properties of Matter, Heat, Light, Sound, and Magnetism and Electricity. 16*s.*

Fluid Dynamics of Jets

SHIH-I PAI, Ph.D.

University of Maryland

Recent rapid developments in jet- and rocket-propelled missiles and aircraft has led to an increased interest in the nature of the flow field of jets. This book on fluid dynamics, while including a discussion of modern developments, thoroughly covers jet flow from fundamentals to such advanced topics as the laminar flow and the turbulent flow of compressible fluid and properties of turbulence fluctuations 37*s.* 6*d*

American Chemical Industry

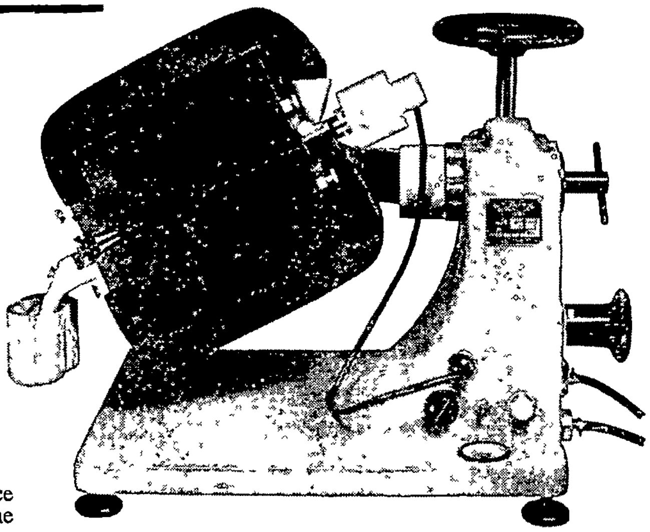
WILLIAMS HAYNES

An exhaustive and scholarly work which considers in chronological order the interwoven technical, economic, social, political and other factors which have influenced the development of American industry. *Volume I* 1608–1910. *Volume II. World War I Period Volume III World War I Period Continued Volume IV The Merger Era Volume V:* 1930–1939 *Volume VI The Chemical Companies* £5 12*s* 6*d* each £28 10*s* the set

All prices are net

St. Martin's Street, London, W.C.2

FRANTZ ISODYNAMIC Magnetic SEPARATOR



* *"A magnificent adjunct to heavy-liquid separation and to quantitative mineragraphy as a tool for the mineral investigator."*

This is the original Isodynamic Separator, made since 1936 and used throughout the world It combines the highest power with the most delicate discrimination, enabling separation of very feebly magnetic minerals, even when their susceptibilities are very close together A typical series separated is

Magnetite ilmenite muscovite . . . tourmaline . . monozite rutile zircon.

* AIME Tech Pub No 1549, "Magnetic Separation of Sulphide Minerals", by A M Gaudin and H R Spedden Copy on request

The magnet is supported adjustably on a massive cast iron base, into which are built the controls for the magnet current and for the vibrator, as well as an ammeter and all the necessary switches.

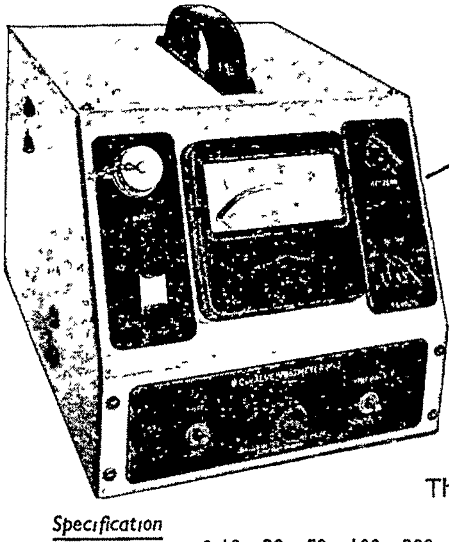
The Isodynamic Separator shown (with slope feed arrangements) is offered optionally without vertical feed at a substantial saving in price Deliveries of new lot starting April 1955.

S. G. FRANTZ CO., Inc...... Engineers

P.O Box 1138, Trenton 6, New Jersey, U S A Cable Address MAGSEP, Trentonnewjersey

---

for **precise** *electrical measurements . . .*



HYZEE

Electrometer Voltmeter

This instrument is based on the well-known 'Farmer' cathode follower circuit. The grid current is of the order of 10^{-11} amps

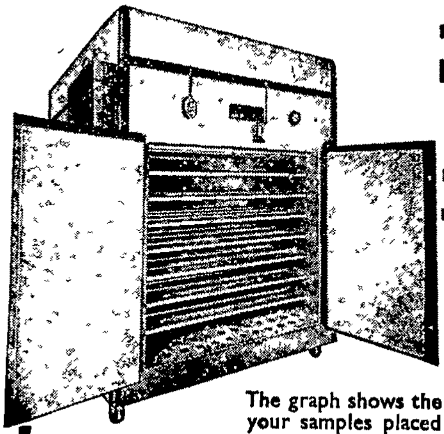
Leaflet No F-116

Specification

Ranges	0-10, 20, 50, 100, 200, 500 volts—either polarity.
Accuracy	± 1 25% of scale reading
Zero Drift	Less than 1% of full scale deflection per hour after five minutes warming on 10 volt range or less on higher ranges.
Mains	±10% deviation from the nominal mains voltage will affect the zero and calibration by less than 0 2v. on all ranges
Power Supply	. 200-250 volts 50 c/s

BALDWIN *scientific instruments*

BALDWIN INSTRUMENT COMPANY LIMITED . DARTFORD KENT . *Telephone :* 2948 (3 *lines*

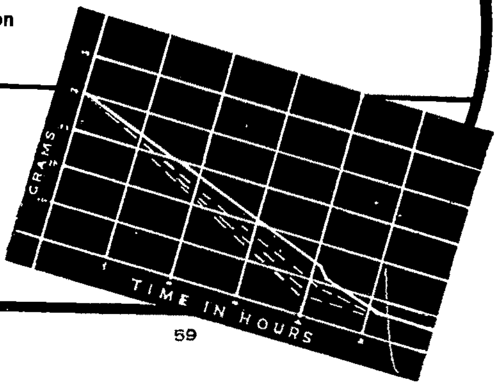


LABORATORY TESTED & APPROVED

The UNITHERM DRIER has been carefully tested under working conditions, and is now being used in Laboratories and Grassland Research Stations all over the world, to provide rapid Uniform Drying at temperatures controlled within ± 2° C. up to 110° from 40° C

The graph shows the uniform rate of drying of your samples placed in different parts of the oven.

Full details will be gladly sent to you upon request



BIRMINGHAM & BLACKBURN CONSTRUCTION CO. LTD.
ARMOURY CLOSE, BORDESLEY GREEN,
BIRMINGHAM, 9
AND HARLEY STREET, BLACKBURN.

59

SPECTROSCOPIC SOLVENTS

2 2 4-Trimethyl-pentane has been added to the series of specially prepared spectroscopic solvents which the B D H catalogue has included for many years. These are already being issued under the new B D H "specification" labels, in which the transmission minima are here shown

SOLVENT	Minimum percentage transmission in a 1 cm cell at	
	220 mμ	250 mμ
Cyclohexane	45	95
Ether	25	80
Ethyl alcohol 95%	50	95
Ethyl alcohol, absolute	50	95
Hexane, fraction from petroleum	70	95
iso-Propyl alcohol	60	95
2 2 4-Trimethyl-pentane ("*iso*-octane")	50	95

Prices for B D H solvents for spectroscopy, in small or large quantities, will be quoted on request

THE BRITISH DRUG HOUSES LTD.
B D H LABORATORY CHEMICALS GROUP POOLE DORSET

SS/LC/551c

CHILEAN IODINE EDUCATIONAL BUREAU

Selected publications—

Iodine—Its Production and Industrial Uses
Element No Fifty-three
Plant Growth and Health
World Goitre Survey
Disinfection of Water
Iodine and Plant Life
Calcium and Iodine Deficiency
Influenza and the Common Cold
Iodine for Animal Health
Industrial Horizons

Iodine Pharmaceuticals
Iodized Salt
Goitre in Animals
Determination of Iodine
Iodine Content of Foods
Iodine in Catalysis
Fire Prevention by Iodine
Polarized Light Developments
The Technics of Iodine
Contrast Media for Radiography

To obtain free copies, or advice and information concerning other aspects of iodine usage, write to:

Chilean Iodine Educational Bureau
STONE HOUSE, BISHOPSGATE, LONDON, E.C 2

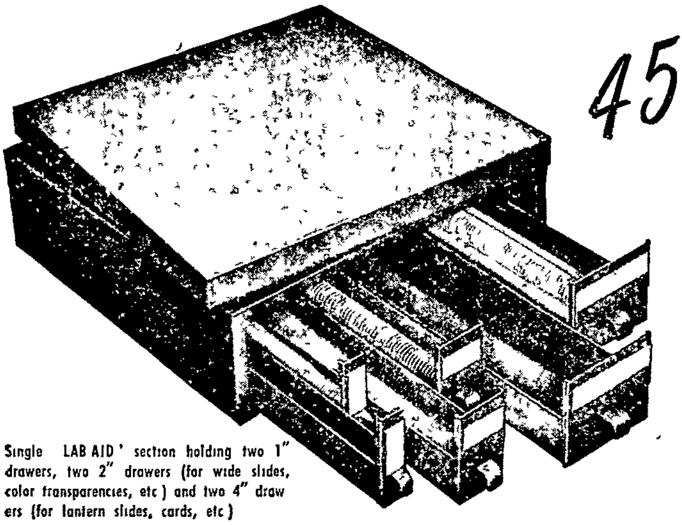
A

NIPA·ESTERS
PARAHYDROXYBENZOATES GALLATES

The well-known & reliable neutral preservatives, antiseptics, antioxidants for all scientific and industrial purposes

NIPAGIN
NIPASOL
NIPACOMBIN
NIPABENZYL
PROGALLIN
PHENOXETOL

NIPA LABORATORIES LTD., TREFOREST TRADING ESTATE, Near CARDIFF
Telephone: Treforest 2128/9
Sole Distributors for the U.K.
P. SAMUELSON & CO, ROMAN WALL HOUSE, 1, CRUTCHED FRIARS, LONDON, E.C.3. *Tel· Royal* 2117/8



45% greater capacity

cuts filing costs . . .

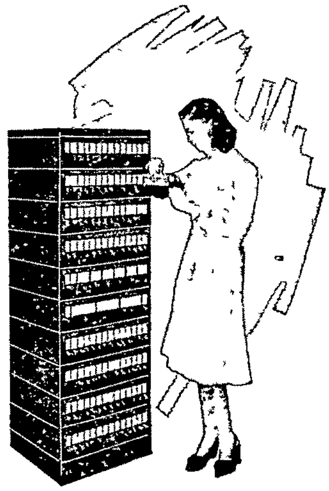
saves floor space

Single 'LAB AID' section holding two 1" drawers, two 2" drawers (for wide slides, color transparencies, etc) and two 4" drawers (for lantern slides, cards, etc)

How can a Technicon "LAB-AID" filing cabinet measuring only 19" square by 5" high hold up to 6500 (average) one-inch microslides? The single section illustrated here with its drawers extended will show you why . . it's because there are no thick bulkheads between drawers — no space-consuming buttresses, no bulky tracking guides Yet, close-set as they are, every drawer slides straight and true easily, smoothly, without binding.

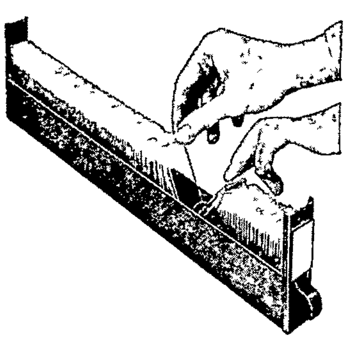
Drawers are freely interchangeable, too, thanks to the unique "LAB-AID" unit-gauge track system, so that you can intermix 1" drawers with 2" drawers (even 4" drawers, if you like) according to your needs

Staunch, fireproof "LAB-AID" units are strongly built of heavy gauge steel for a lifetime of satisfactory use Beautifully finished in olive green enamel, with combination drawer-pulls and label holders Separate bases and finishing cap panels make complete units of any number of sections your filing needs require, expandable at will at any future time.



A stack of ten sections, complete with base and cap panel Interlocking design lets you pile sections right up to the ceiling Staunch 'LAB AID' construction easily bears the heavy weight of solidly packed slides

For filing current slides, the removable spring separator lets you riffle through them as easily as you flip the pages of a book easy to file, easy to find Slip it in when you need it, take it out when you use the drawer for storage filing



TECHNICON

Lab-aid **laboratory filing cabinets**

Technicon "LAB-AID" filing cabinets have long been standard filing equipment in laboratories throughout the world Now made in France, they can be easily imported into the United Kingdom.

COMPAGNIE TECHNICON
Postal Address only in U.K :
7 Lytton Gardens, Wallington, Surrey

Tracer Compounds for Chemical & Biological Research

Some recent additions to our C.14 list :—

Margaric acid-1-C14
Glyceryl tri (stearate-1-C14) (Tristearin)
Glyceryl tri (palmitate-1-C14) (Tripalmitin)
Glyceryl tri (stearate-2-C14) (Tristearin)
Succinic acid-1-C14
Fumaric acid-1-C14
Maleic anhydride-1-C14
Phenyl (acetic acid-1-C14)
Cetyl alcohol-1-C14
Aniline hydrochloride (generally labelled)
D-Glucose-1-C14
D-Glucono-*delta*-lactone-1-C14
D-Mannose-1-C14
Carbon (elementary)
Sodium *iso*-caproate-1-C14
DL-Leucine-1-C14
Sodium pyruvate-2-C14
Sodium pyruvate-3-C14

•

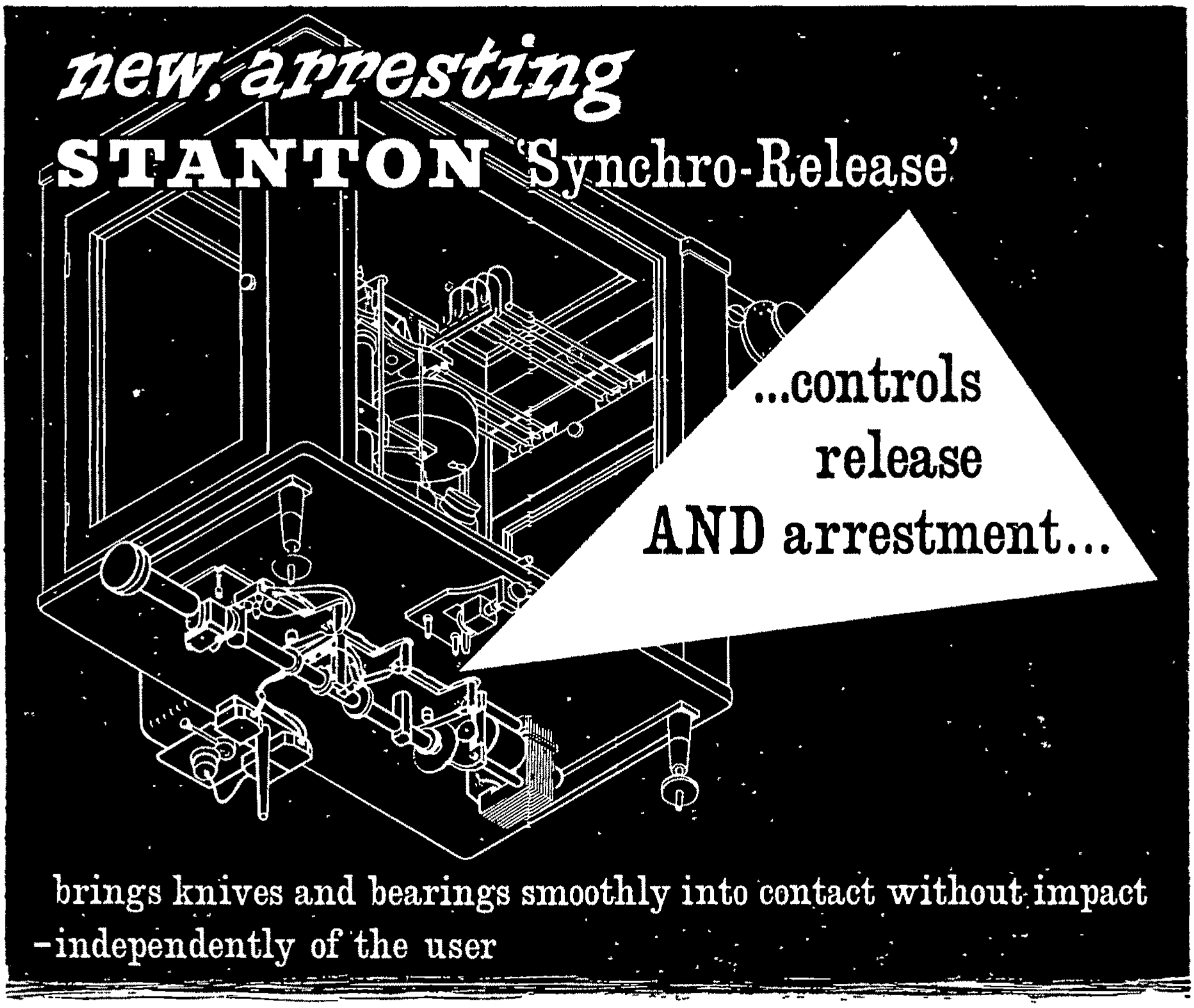
We can now supply more than one hundred compounds of carbon-14.

•

For further information write to.
THE RADIOCHEMICAL CENTRE, AMERSHAM, BUCKINGHAMSHIRE,
ENGLAND

These products are distributed in U.S.A by the Nuclear Instrument and Chemical Corporation of Chicago

TAS/RC.8.


new, arresting
STANTON 'Synchro-Release'
...controls
release
AND arrestment...
brings knives and bearings smoothly into contact without impact
-independently of the user

The most careful chemist could not release a balance more smoothly than the Stanton "Synchro-Release" device So gently controlled is the automatic motion of the "Synchro-Release" mechanism that knife edges and bearings are brought into contact swiftly, safely, accurately, without the slightest jarring or vibration of impact no matter how hurried or unskilled the operator may be

ALL Stanton balances can now be supplied with "Synchro-Release" giving these extra advantages —

- **Safely controls arrestment as well as release.**
- **No loss in weighing time.**
- **Ensures sustained accuracy on routine weighings**
- **Simple, sturdy synchronous device—nothing to go wrong.**
- **Facilitates training of laboratory personnel.**
- **Reduces balance operating costs.**

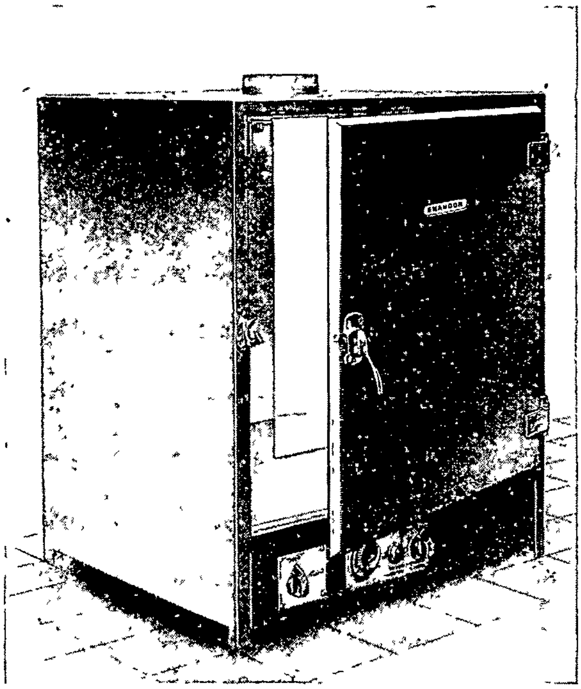
SEND TO-DAY *for illustrated leaflet giving full details of this amazing new improvement*

STANTON
precision balances

Please send me a free copy of "Contact without Impact"
STANTON INSTRUMENTS LTD., (DEPT N 5,)
119 OXFORD STREET, LONDON, W 1
Name
Address

SHANDON

CHROMATOGRAPHY DRYING OVEN

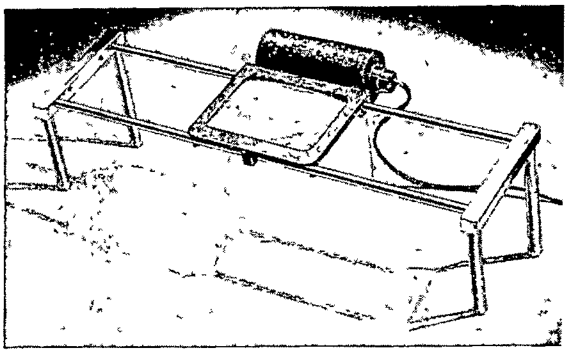


Specially designed for chromatography and paper electrophoresis, this Shandon equipment offers

- ★ Drying of papers at **uniform temperatures,** a feature which is **indispensable for consistently accurate, reproducible, and comparable chromatograms.**
- ★ Simultaneous drying of **12 large sheets up to 24 in × 24 in.,** hung on **pull-out rack** giving free access to all papers
- ★ Heating of all papers under strictly identical conditions through continuous horizontal **forced air circulation** by centrifugal fan
- ★ Accurately **controlled heating** from ambient temperature to **150° C.** by manual or fully automatic regulation
- ★ **Solvent vapours continually exhausted** through adjustable outlet (*The oven can also be run as a closed system*)
- ★ Shelves are available for immediate conversion into **general purpose laboratory oven.**

SHANDON

SHANDON SCIENTIFIC COMPANY LTD.
6 CROMWELL PLACE, LONDON, S W 7
Telephone KNIghtsbridge 1131



THE ROLAMA

MAGNIFIERS

This is one instrument from our wide rang of illuminated and non-illuminated magnifier designed for industry, research and education purposes, which includes Linen Testers, Watc maker's eye-glasses, Magna-forceps ; single, doubl and triple magnifiers, folding magnifiers, pocke pencil microscopes, etc.

Full details sent on request.

BRITEX (SCIENTIFIC INSTRUMENTS) LTD.
Manufacturers of Microscopes, Magnifiers, Telescopes, etc
523 4, Bank Chambers, 329, High Holborn, London, W C I
HOLborn 7166 and 0902

CARL ZEISS

Zeiss instruments of all types repaired and overhauled by Zeiss-trained technicians

DEGENHARDT & CO. LTD.
32 MADDOX STREET, LONDON, W1
Mayfair 6639

SOLE ZEISS AGENTS FOR GT BRITAIN
AND N IRELAND

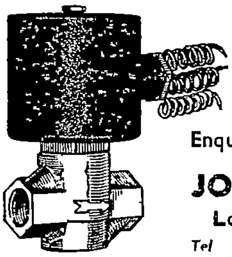
The circular plate in this illustration is the largest piece of high optical quality fused quartz ever made—200 mm diameter, 30 mm thick Quality Ultrasil

WE are the sole agents in Great Britain for the optical qualities of fused quartz manufactured by HERAEUS Quarzschmelze G m b H , Hanau Stocks of the various qualities are carried in London, and good delivery can usually be offered

Optical elements from these unique materials to any standard of accuracy can be supplied

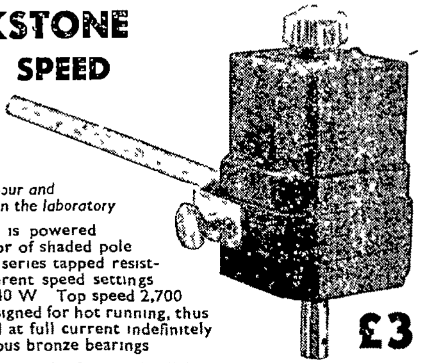
QUARTZGLASS
LIMITED
FOREST ROAD BARKINGSIDE ESSEX
HAINAULT 5454–5

Concordia Valves



SOLENOID VALVES
Temperature and Pressure
CONTROLS
Enquiries for special applications Invited
JONES & STEVENS LTD.
Long Lane, Littlemore, Oxford
Tel Oxford 77912 Cables Instruments Oxford

THE PICKSTONE VARIABLE SPEED STIRRER UNIT



lesigned to lighten labour and
:xpedite experiments in the laboratory
This STIRRER UNIT is powered
y an induction motor of shaded pole
ype incorporating a series tapped resist-
nce, giving ten different speed settings
ower consumption 40 W Top speed 2,700
P M Windings designed for hot running, thus
notor may be stalled at full current indefinitely
Dil impregnated porous bronze bearings

£3
Including packing and post in U K

Sole Manufacturers R E PICKSTONE LTD , 56-60 Islington Park Street, London, N I
Telephone CANonbury 6190

Manufacturers of optical elements for laboratories and instrument makers

M. Bender (Northern) Ltd.

Optical Works—
5-21, High Friar Street,
Newcastle upon Tyne, 1
Tel 2-4005/6

"Whatever do you use all this Glass Tubing for?..."

" Oh, that's 'PYREX' for all sorts of things, from gauge glasses to heat exchangers, from hypodermic syringes to condensers, and we are now buying large supplies of special thin wall tubing for the manufacture of B.S. Ampoules "

" Surely 'PYREX' tubing can't be made thin enough for ampoule work!"

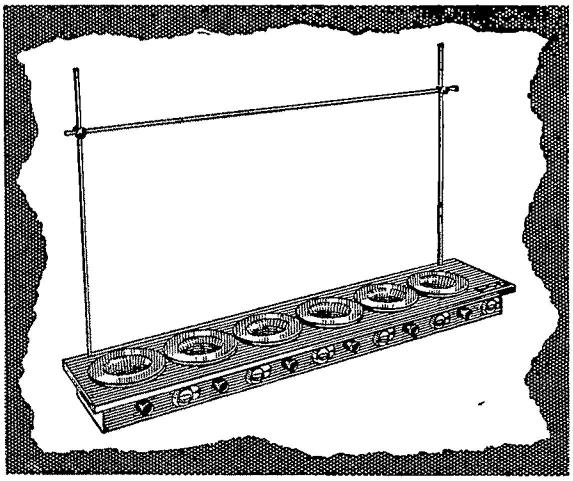
" Oh yes, it can. We are buying it with a wall thickness down to point four millimetres. The great advantage, of course, is that its heat and chemical resistant properties reduce the losses in sealing the ampoules, and give added protection to the contents "

- 'PYREX' *Brand Tubing, which is of the same composition as* 'PYREX' *Laboratory ware, is supplied in standard, heavy and extra heavy wall grades, in diameters ranging from 3 to 100 mm. Special Thin Wall Tubing is available for the manufacture of Ampoules, and Precision Bore Tubing from 1.5 mm to 42 mm bore is available with bore tolerances of ±0.05 mm. For special purposes, Precision Bore Tubing with tolerances of ±0.02 mm can be supplied*

MADE IN ENGLAND PYREX REGD TRADE MARK

JAMES A JOBLING & CO LTD
Wear Glass Works Sunderland

THE ONLY MAKERS OF 'PYREX' BRAND GLASS IN UNITED KINGDOM



EXTRACTION UNITS

(Patented)

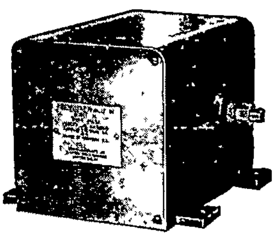
Electrothermal offers the most efficient and up to date equipment for Soxhlet and other tests. Available from your usual Laboratory Supplier in standard 3 and 6 test units—flask capacity 100 ml — 1000 ml. Non-standard apparatus built to specification

Write for leaflet today

Safe, efficient and economical in use.

Electrothermal Engineering Ltd.

270 NEVILLE ROAD, LONDON, E.7 Telephone GRAngewood 0055



SENSITIVE

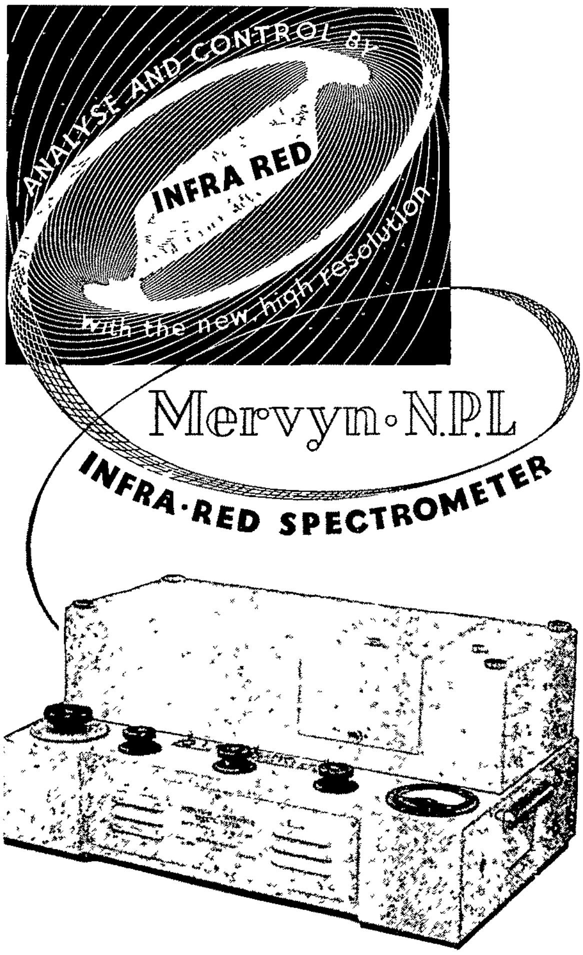
PRESSURE SWITCH

TYPE PV/LI

The Type PV/LI pressure/suction switch operates in the range from $\frac{1}{2}$ in. to 10 in. w.g., and may be used with non-corrosive gases or liquids in ambient temperatures up to 120° C. The instrument uses a large bellows as the pressure sensitive unit, which is coupled through suitable linkages to a heavy duty mercury switch

A catalogue describing the switch shown above and other models is available on request

DELTA TECHNICAL SERVICES LTD
FAIRFIELD ROAD . KINGSTON-ON-THAMES . SURREY
TEL. KINgston 9568-9



NOW—Infra-red analysis enters a new phase with the development of this Mervyn engineered instrument using Merton—N.P.L. diffraction gratings.

Here is the long awaited high resolution instrument for the 1 μ — 4 μ region. Of great stability, it reads percentage transmissions direct.

USING A COMPLETELY NEW ELECTRONIC COMPENSATING SYSTEM

This versatile instrument is compact and simple to operate Has many applications in the manufacture of petroleum products, plastics, detergents, pharmaceuticals and other processes where the high cost of contemporary equipment has restricted the use of Infra-Red techniques.

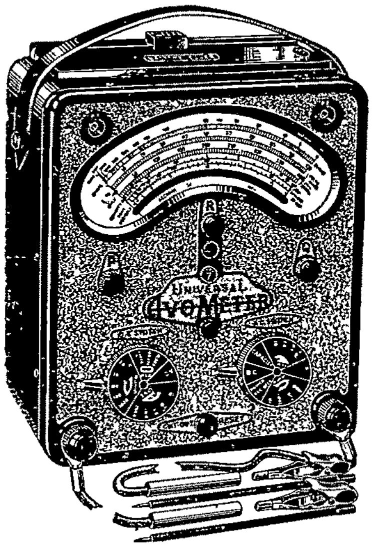
Send for full information to Dept IS 4

MERVYN INSTRUMENTS
ST. JOHN'S, WOKING, SURREY.
Telephone WOKING 2091

PB 01

Instrumentally Speaking

Wherever electricity is used in industry, there is a need for electrical measuring instruments. Phenomenal development in the war and post-war years has produced a need for such a multiplicity of instruments of different kinds that there is a prevailing tendency towards the slowing down of maintenance and laboratory work through having too many instruments in use. Incidentally, too much test gear also means too much expense. The answer to such problems is provided by "Avo" MULTI-RANGE instruments.



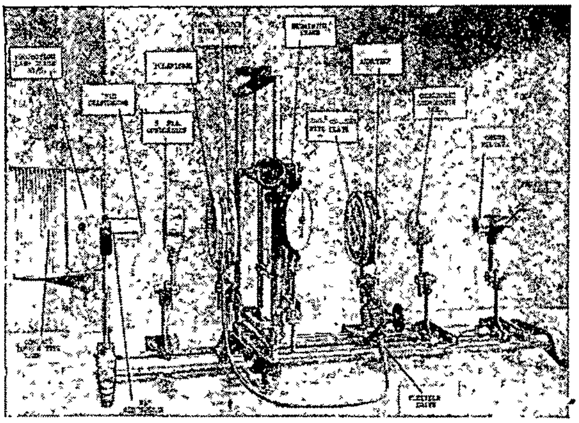
The Model 7 Universal AvoMeter is a typical example of a modern "AVO" multi-range meter It is a combination A C /D C instrument providing on a 5-inch hand calibrated scale 50 ranges of readings of Current, Voltage, Resistance, Capacitance, Power Output and Decibels The total resistance of the instrument is 500,000 ohms, and its small power consumption and precision accuracy make it the choice of radio, television and electrical engineers throughout the world An external accessory is also available for measuring Power and Power Factor

Write for a FREE copy of the latest Comprehensive Guide to "AVO" Instruments

"AVO" *Precision* ELECTRICAL TESTING INSTRUMENTS

MODEL 7 UNIVERSAL AVOMETER
MODEL 8 UNIVERSAL AVOMETER
MODEL 40 UNIVERSAL AVOMETER
HEAVY DUTY AVOMETER
"AVO" ELECTRONIC TESTMETER
"AVO" ELECTRONIC TEST UNIT
"AVO" SIGNAL GENERATOR
"AVO" UNIVERSAL BRIDGE
"AVO" VALVE CHARACTERISTIC METER
D.C. & UNIVERSAL AVOMINORS
"AVO" LIGHT METER
etc., etc.

Sole Proprietors and Manufacturers:
The Automatic Coil Winder & Electrical Equipment Co. Ltd.
Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1
VICtoria 3404-9



J. L. PHOTOELASTIC OPTICAL BENCH

Facilitates the complete photo-elastic investigation of a wide range of engineering stress problems Accurate and rapid in operation it is readily adaptable for varied problems The bench permits all methods of observation including photography, projection on to a screen, microscopic, etc

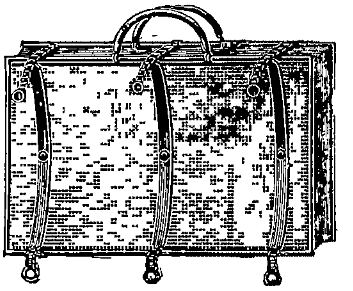
Fuller details gladly sent on request

HUMMEL OPTICAL CO. LTD.

New House, 67-8, Hatton Garden, London, E.C.1
Telephone HOLborn 1752

BOTANICAL EQUIPMENT

Woven Wire Plant Press



Fitted with springs and chains for adjusting pressure.

Size 18½ in × 12½ in.

We also stock:

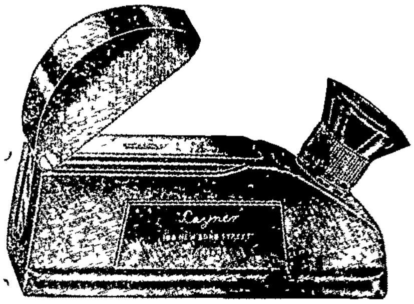
Green's Hand-made Drying Paper, Mounting Paper, Genus Covers, Vascula, etc.

Write for leaflet N/B.

PART OF OUR COMPREHENSIVE SERVICE TO BIOLOGISTS

FLATTERS & GARNETT LTD.
309 Oxford Road, Manchester, 13
Over 50 Years' Service to Microscopy

RAYNER REFRACTOMETER



Price: In case with 1·81 fluid, yellow filter and polarizing filter, £15 16s

Scale 1·30–1·86 in intervals of 0·01 Estimation to 0·001 in white light with filter. Designed for mineralogy, gemmology, routine checks for transparent solids, and for much work with fluids

RAYNER
100 NEW BOND STREET, LONDON, W 1
Telephone GRO 5081

POLAROGRAPHY

The 'Electrochemical Laboratories' Manual Polarographs are designed for plotting polarograms with ease, speed and accuracy

MODEL A For the analysis of solutions of moderate concentrations

MODEL B MK II. For all polarographic work in industry and research

HYDROGEN GENERATOR D C Power Supply and Electrolytic Cell, giving 2,000 c c H_2 per hour.

Full details on request

ELECTROCHEMICAL LABORATORIES
5, Highfield, Wardle Road, Sale, Manchester.
Tel. Sale 5851, 6529

MICROSCOPES

Secondhand Bargains

Busch Research binocular, £75 10s , Bausch & Lomb Research binocular, £89 10s , Watson "Service," 2 objectives, £28 10s , Beck Medical, 3 objectives, £33 10s , C T & S Medical, 2 objectives, £27 10s , Leitz Medical, 3 objectives, £32 10s , Beck laboratory, 3 objectives, £39 10s , Watson "Service" mech stage, 3 objectives, £48 10s , Leitz laboratory, 3 objectives, £52 10s Himmler Medical, 3 objectives, £25 , Watson "Bactil" (Monocular), £52 10s

BY APPOINTMENT TO
H.M. QUEEN ELIZABETH THE QUEEN MOTHER —— THE LATE KING GEORGE VI ——
SUPPLIERS OF PHOTOGRAPHIC EQUIPMENT

WALLACE HEATON LTD

127 NEW BOND STREET, LONDON, W1 **MAYFAIR 7511**

THERMOSTATIC WATER BATHS MADE BY GRANT INSTRUMENTS

(1) Cover the range from 10° to 90° C., with a differential of ± 0 25° C. The whole range is clearly marked out on the dial, in single degrees, and the required temperature can be precisely set

(2) Are fitted with an accurate bimetallic thermostat, of new design, which works on the micro-switch principle without a relay and without arcing at the contacts

(3) Have extremely efficient stirring, by induction motor, which ensures that there is no measurable temperature gradient throughout the bath.

(4) Have 1500 or 3000 watt heaters which give very rapid heating

(5) Can now be fitted with fan cooling to the control box, recommended for continuous operation over 40° C , to prevent overheating and condensation

(6) Are protected by a strong wooden casing, with air gap, giving good heat insulation.

(7) Are unconditionally guaranteed for 12 months, and covered by a 48 hour repair service

Type UB2 is a heavy steel pressing, vitreous enamelled. The non-drip lid is of aluminium All SB types are of stainless steel with stainless steel non-drip lids.

Standard Types	*UB2*	*SB1*	*SB2*	*SB3*
Working Space	18″×8¼″×6¼″	10″×8¼″×7″	17″×8¼″×8″	21½″×12″×11½″
Shipping Weight	56 lb.	48 lb.	56 lb	100 lb.
Export packing	£2 10 0	£2 10 0	£2 10 0	£3 0 0
PRICE	**£22 10 0**	**£25 5 0**	**£26 10 0**	**£29 0 0**

Lids, non-drip UB2, 39/-, SB1, 49/-, SB2, 60/-, SB3, 95/- Constant Level Device, Cooling System (all baths), 30/- each Fan Cooling (all baths), 40/-. Standard Test Tube racks for all tube sizes available in stainless steel or aluminium.

We shall be glad to send any further information required, but have tried to set out above, as clearly as possible, the most important information which an intending user might need to know

GRANT INSTRUMENTS, 8-9 PETTY CURY, CAMBRIDGE. *Telephone* 3580

Official repairing agents in Great Britain for Carl Zeiss of Jena and Bausch & Lomb, U S.A

ZEISS APPARATUS

We can undertake to overhaul and repair most Zeiss instruments Mr Perkins has specialized in Leitz and Zeiss instruments since 1909, and was in charge of the London repair shops of these firms for fifteen years When original spares are not obtainable, we can generally manufacture replacements

B. COOK & S. PERKINS

Pembroke Works, Pembroke Rd., Muswell Hill, London, N.10 *Telephone* TUDor 9731-2-3

Leslie Dixon & Co.

SPECIALISTS IN LABORATORY AND TEST GEAR

Designed and made to specification Lab tested and guaranteed

NIFE BATTERIES, new surplus, long life, 12 volt 45 a h , comprising en 1 2 volt cells in wood crate, **£12 10s** , carr 10/– Single cells 1 2 volts, 5 a h , 30/–, post 2/–

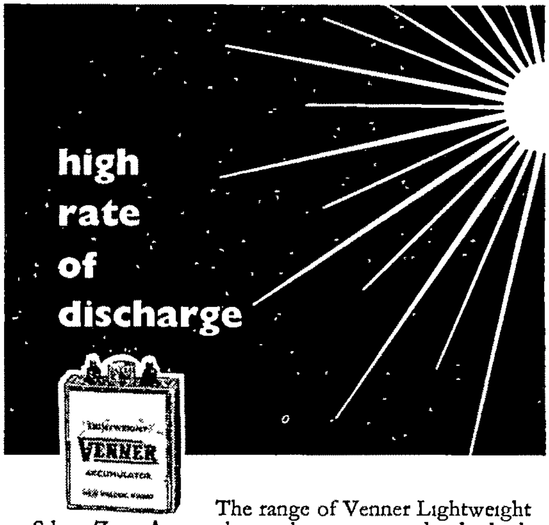
CONTACTORS, by leading makers D P on-off with auxiliary circuit for ell or light, or 3-pole on-off arranged with slow make action for 1 or 2 seconds, quick break 415 volts, 15 amps , with operating coil wound for 15 volts A C or to specification

TUNGAR BATTERY CHARGERS, for charging 12 volt accumulators, 30 volts, 50 cycles, input 75 volts,, 6 amps output, brand new and complete with Tungar valve ready for use **£16 10s** , carr extra

TRANSFORMERS, VARIABLE RESISTANCES, VARIACS, MOTORS, ALTERNATORS, FREQUENCY METERS *Send us your enquiries for any aboratory equipment required*

Dept M, 214 Queenstown Road, Battersea, London, S W 8

Telephone M4Caulay 2159



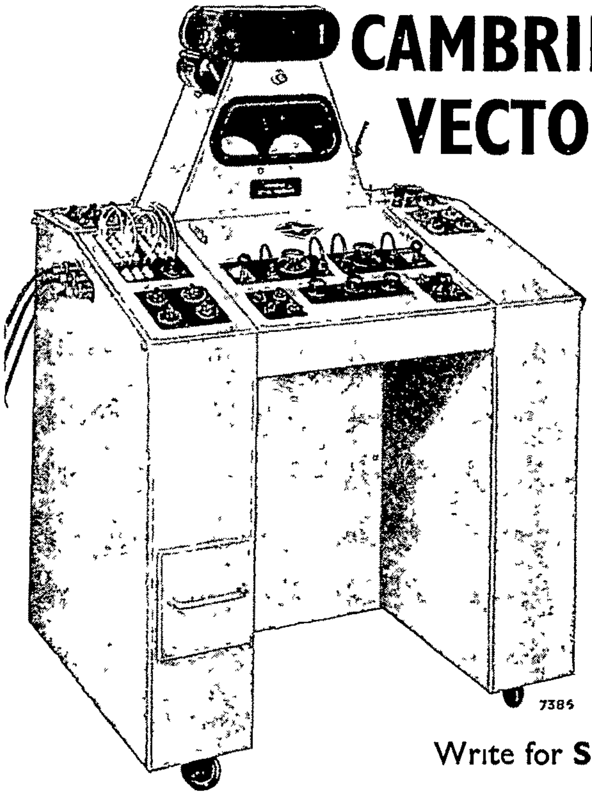
The range of Venner Lightweight Silver-Zinc Accumulators has an exceedingly high rate of discharge with very little drop in effective capacity. Wherever excess weight and size are serious disadvantages in electrical storage, the Silver-Zinc Accumulator is indispensable

Write for full technical details and catalogue N

VENNER ACCUMULATORS Ltd
Kingston-By-Pass, New Malden, Surrey
Phone . MALden 2442

VENNER ACCUMULATORS

Associated Companies. Venner Limited—Venner Electronics Ltd



CAMBRIDGE RECORDING VECTOR CARDIOGRAPH

The most complete and versatile instrument of this type yet available.

Will simultaneously record any 2 vector and/or scalar electrocardiograms with 12-lead control. Also phono-cardiograms or other physiological phenomena.

Modulated brightness control.

Time marking by ruling or by interrupted beam. Facilities for photographing unrolled vector loops, etc., etc.

Write for **SHEET 317-N**

CAMBRIDGE
INSTRUMENT CO. LTD.
13 GROSVENOR PLACE, LONDON, S.W.1
WORKS LONDON & CAMBRIDGE

53

We Export for Dollars

WM. DAWSON & SONS, LTD.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to All Leading Universities, Public Libraries and Institutions of the World. Catalogues issued

SELLING?

Specialists in Scientific, Technical Books and Publications of all Learned Societies

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephones: Wel. 7948; *Amb.* 5991

were then further diluted with 0 2 M sodium chloride to obtain the very low concentrations used. The experiments have been carried out with the 'Spinco' model E ultracentrifuge fitted with an ultra-violet absorption observation system working in the wavelength region 248–265μ

We have found that at concentrations of deoxyribonucleic acid less than 1 × 10^{-4} gm /ml the boundary shows a very marked degree of spreading The essential problem at these low concentrations is to determine whether this is due to the inherent instability of the boundary, or whether it corresponds to a real heterogeneity of sedimentation coefficients We have used two criteria to determine whether the boundary is stable.

First, the calculated sedimentation coefficients should be reproducible and should increase steadily as the concentration of deoxyribonucleic acid is reduced As is shown in Fig 1, the reproducibility of the results is of the order of ± 10 per cent At concentrations less than 5 × 10^{-5} gm /ml. the sedimentation coefficients are somewhat lower than expected, and this and other evidence given later suggests that at such concentrations the boundary is not stable. The mean sedimentation constant at zero concentration is about 24 S. This value is higher than has been previously found by extrapolation from results obtained at higher concentrations[2,3,5].

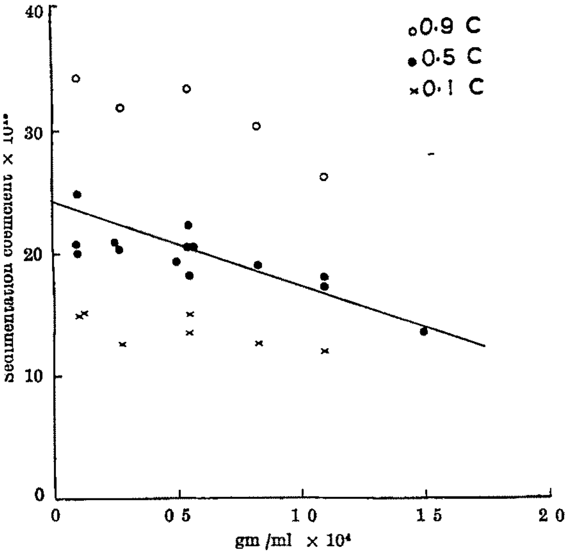


Fig 1 Variation of the sedimentation coefficient with concentration deoxyribonucleic acid in 0 2 M sodium chloride

A second and more definite criterion that we have used is to determine whether the spreading of the boundary, in terms of sedimentation coefficients, changes with time of sedimentation. When sedimentation begins, the boundary is at the meniscus (a distance x_0 from the centre of rotation), and is nfinitely sharp After a time of sedimentation (t), the distance from the centre of rotation to points in the boundary where the concentration is 0 1, 0 5 and 0 9 of the total concentration has been measured x) If the boundary remains undisturbed during sedimentation, then a plot of log x versus t should give a straight line for each concentration, and the three lines should extrapolate to a point at log x = og x_0. It has been found that at concentrations down to 5 × 10^{-5} gm./ml deoxyribonucleic acid this test shows that the boundary is stable (Fig 2) At lower concentrations, although the points fit straight-line plots fairly well, the three lines do not converge to a point at log x_0. The main cause of the instability of the boundary will be the stirring effects of thermal currents, and these will be most marked during the adiabatic cooling of the rotor during acceleration[6,7]. These results also show that the spreading due to diffusion is negligible in these experiments.

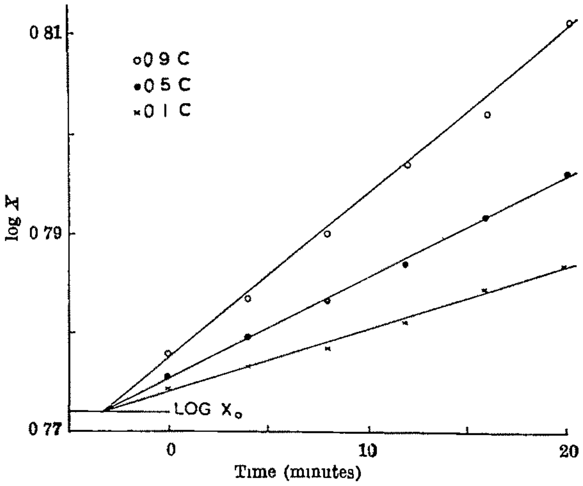


Fig 2 5 5 × 10^{-4} gm deoxyribonucleic acid/ml in 0 2 M sodium chloride the slopes of the lines give the sedimentation coefficients for concentrations 0 1, 0 5 and 0 9 times the total concentration

These results have been further analysed to determine the distribution of sedimentation coefficients From the photographs taken during sedimentation, the plot of optical density of the solution versus distance down the cell is obtained. This can be transposed to a plot of optical density versus sedimentation coefficient, and the first derivative of this curve gives an apparent sedimentation distribution. The correction for dilution resulting from sedimentation in a sector-shaped cell is applied at this stage[8]. Fig. 3 shows the distribution diagrams obtained for solutions containing 11 and 5 5 × 10^{-5} gm./ml deoxyribonucleic acid. It is obvious that the deoxyribonucleic acid preparation is extremely heterogeneous. If it is assumed that for each molecular species the absorption is proportional to concentration, then the ordinates of Fig 3 give the weight-fraction of the deoxyribonucleic acid having a particular sedimentation coefficient. Comparison of the shapes of the two distributions in Fig. 3 shows that at 11 × 10^{-5} gm /ml. some self-sharpening of the boundary due to the Johnston–Ogston[9] effect occurs, whereas at the lower concentration there is no obvious self-sharpening of the boundary. Since, however, interaction may still occur at the lower concentration, the curve of Fig. 3 may not represent the true distribution of sedimentation constants. It may be noted that for a system consisting of rigid

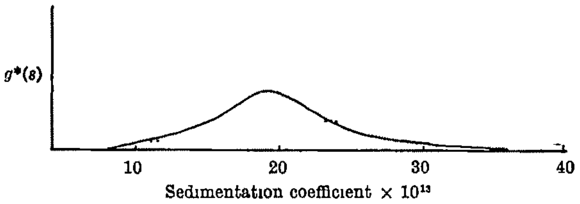


Fig 3 Apparent distribution curves for deoxyribonucleic acid, full line, 11 × 10^{-5} gm /ml , dotted line, 5 5 × 10^{-5} gm /ml

rods of constant cross-section, the sedimentation coefficient should be almost independent of the length of the rods[8]. The marked heterogeneity of sedimentation constants found suggests that either the deoxyribonucleic acid molecules are to some extent flexible or that their diameter is variable, possibly as a result of aggregation. The effect of aggregation and other types of interaction that occur in this region of concentration requires further investigation before unambiguous conclusions as to the meaning of the heterogeneity can be drawn.

This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Services. [Dec. 22

[1] Philpot, J. St. L., *Nature*, **141**, 283 (1938). Svensson, H., *Kolloid Z.*, **87**, 181 (1939).
[2] Peacocke, A. R., and Schachmann, H. K., *Biochim. Biophys. Acta*, **15**, 198 (1954).
[3] Reichman, M. A., Rice, S. A., Thomas, C. A., and Doty, P., *J. Amer. Chem. Soc.*, **76**, 3047 (1955).
[4] Butler, J. A. V., Conway, B. E., and James, D. W. F., *Trans. Farad. Soc.*, **50**, 612 (1954).
[5] Davison, P. F., Conway, B. E., and Butler, J. A. V., "Progr. Biophysics", **4**, 148 (1954).
[6] Waugh, D. F., and Yphantis, D. A., *Rev. Sci. Instr.*, **23**, 609 (1954).
[7] Biancheria, A., and Keseles, G., *J. Amer. Chem. Soc.*, **76**, 3737 (1954).
[8] Svedberg, T., and Pedersen, K. O., "The Ultracentrifuge" (Oxford Univ. Press, 1940).
[9] Johnston, J. P., and Ogston, A. G., *Trans. Farad. Soc.*, **42**, 789 (1946).

DISTRIBUTION OF RADIO BRIGHTNESS ACROSS THE ANDROMEDA NEBULA

By Prof. JOHN D. KRAUS

Radio Observatory, Dept. of Electrical Engineering, Ohio State University

USING the 96-helix antenna and improved receiver of the Ohio State University radio telescope (Kraus and Stoutenburg, in preparation), observations have been made of the radio brightness across the Andromeda nebula (*M*31) at 250 Mc./sec. A radio source near the nebula's position was detected by Ryle, Smith and Elsmore[1] at Cambridge about 1950. However, it remained for Hanbury Brown and Hazard[2] at Manchester in 1950 to make the first positive identification of a radio source with the nebula. Their observations stand as an epic achievement of radio astronomy, since it was the first radio source to be definitely identified with an extragalactic object.

The Andromeda nebula is a galactic system similar to the galaxy in which we are located. It is classified as an *Sb*-type spiral nebula with its axis tilted about 75° from our direction. At a distance of one and one-half million light years, this sister system is a weak radio source and was near the limits of detection of the Manchester radio telescope. At Ohio it was detected with a much smaller, although more efficient, antenna with less resolution in declination but higher resolution in right ascension than the Manchester antenna. The Ohio antenna is 160 ft. long (east–west) and 22 ft. wide (north–south), with an aperture area of 3,520 sq. ft., and operates as a meridian circle instrument. The Manchester antenna, a fixed paraboloid 218 ft. in diameter with an aperture of 37,400 sq. ft., is more than ten times as large.

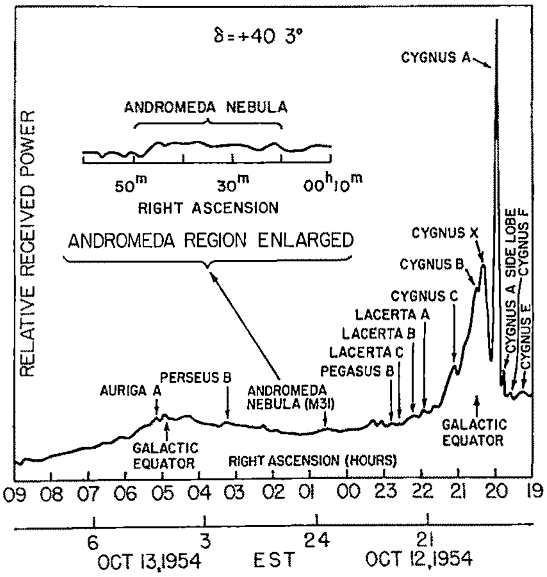


Fig. 1. Single profile taken with the Ohio State University radio telescope on the night of October 12–13, 1954. The largest peak is due to the radio source Cygnus *A*. The Andromeda nebula appears as a small hump near R.A. 00h. 40m. The insert shows the Andromeda region to a larger scale

The Andromeda nebula is situated in a minimum of the cosmic radio background. This is illustrated by Fig. 1, which is a profile of the received power versus time (or right ascension) as obtained with the Ohio State radio telescope on the night of October 12–13, 1954, at a declination of 40 3° N. A large rise near R.A. 20h. 30m. and another smaller one near R.A. 05h. 00m. occur at the galactic equator. The Andromeda nebula is in the valley between them.

The most prominent peak in Fig. 1 is due to the radio source Cygnus *A*. A number of other localized sources[3] are also designated by name. The insert in Fig. 1 is an enlargement of the profile for the Andromeda nebula region showing the record for the night of October 12 to a larger scale.

By averaging six profiles taken at Dec. 41° N. ± 0 7° between October 11 and 17, 1954, it was possible to reduce the random fluctuation of the profile by a factor of approximately 2 5 (= $\sqrt{6}$). This averaged profile (radio brightness) is shown at the top of Fig. 2. This curve indicates that although the radio emission from the nebula is strongest between R.A. 00h. 27m. and 00h. 45m., there is a suggestion of emission out to R.A. 00h. 20m. on the preceding side and to 00h. 51m. on the following side. The slowly varying background gradient has been subtracted from this curve.

For comparison, smoothed contours of optical brightness (isophotes) of the Andromeda nebula are shown at the centre of Fig. 2 as measured by Williams and Hiltner[4]. It is apparent that the strongest part of the radio emission (marked "main body") corresponds in position to the region enclosed by their isophote contour 2. The curve at the bottom of Fig. 2 labelled "photographic brightness" shows how the nebula would appear optically to a device having the same response pattern as our antenna, assuming a uniform optical emission from the region within contour 2. The curve was obtained by moving the

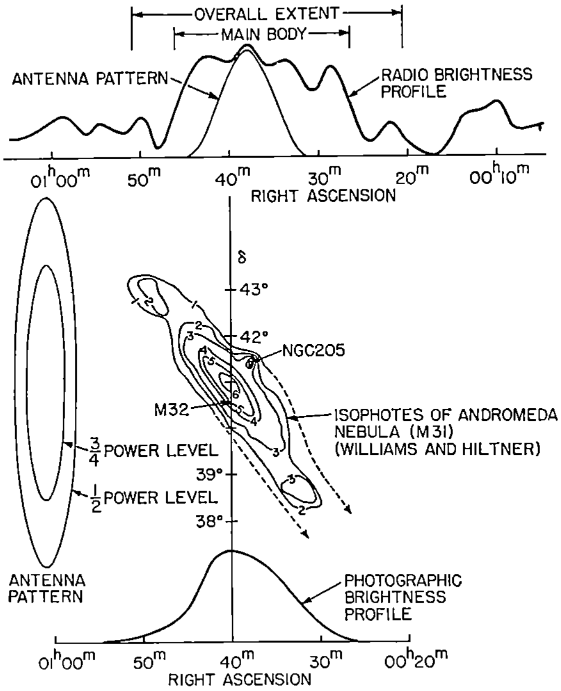


Fig 2 Radio brightness profile (top curve) across the Andromeda nebula obtained by averaging six records taken with the Ohio State University radio telescope at a declination of approximately 41° N The ordinate is relative radio brightness Isophotes for *M*31 as measured by Williams and Hiltner are shown at the centre with a photographic brightness profile (bottom curve) that would be observed with an optical system having the same response pattern as our antenna

antenna pattern (at left of Fig 2) along the Dec 41° N. line across the contour of the nebula and computing graphically the received intensity at successive positions The antenna pattern (for a point source) is 1·3° wide between half-power points in right ascension and 8° wide in declination The wide beam-width in declination is sufficient to bring all contour 2 within the half-power level when the antenna is at Dec. 41° N.

The optical brightness actually increases toward the nucleus (at R A. 00h 40m), as shown by the higher contour levels, so that the assumption of uniform emission inside contour 2 should increase the extent of the nebula as shown by the normalized photographic brightness curve In spite of this fact, the photographic brightness curve shows a smaller extent for the nebula than does the radio brightness curve, indicating that the radio emission must be much larger in the outer regions of the nebula than the optical brightness would suggest Furthermore, the ratio of the radio to photographic brightness for the outer regions must be much higher than the ratio of the radio to photographic intensity for the nebula as a whole

The amount of significance that can be attached to the small peaks near R A 00h 22m., 29m. and 50m is not certain. However, the outer ones are sufficiently separated to be due to small areas or bands of emission which can just be resolved by our antenna (1·3° resolution) It is probable that a small increase in resolution would reveal considerably more such fine structure

Since the nucleus of Andromeda *M*31 is close to R A. 00h. 40m at Dec. 41° N , the radio brightness distribution indicates that the nebula is quite asymmetrical The main body appears to extend 3·5° from the nucleus to the south-preceding side and 1·7° to the north-following side. This extent agrees closely with that of Williams and Hiltner's contour 2. If the peaks on the radio brightness curve at R.A. 00h 22m. and 50m. are significant, it indicates an approximate overall extent of the nebula of 6° to the south-preceding side and 3° to the north-following side (ratio 2/1), giving an overall diameter of 9° At a distance of 1·63 million light years (new scale)[5] this means an overall diameter for the nebula of 256,000 light years

From their isophotes, Williams[4] and Hiltner indicated that the extent of the nebula was at least 6·7° Their contour 1 was found to extend so far to the south-preceding side that they could not close it on the original negative and it is shown only in part (solid line) , the broken line suggests what is presumed to be the general trend of this contour beyond the extent given by Williams and Hiltner. The extent of the Andromeda nebula usually seen on a photograph is about 2°, corresponding to Williams and Hiltner's contour 4 or 5

Preliminary attempts have been made to construct a model of *M*31 to fit the radio brightness contours of Fig 2 It is readily possible to obtain an approximate fit by assuming a structure of eccentric emitting rings of increasing size with gaps between them that are especially large for the outermost rings.

In addition to the measurements reported above, profiles across *M*31 were made with the Ohio State University radio telescope later in October at Dec 44° and 37·5° N. At Dec. 44° N , the main part of the rise in the brightness curve is about 5 min. later than at Dec. 41° N., while at 37·5° it occurs about 5 min. earlier. By the dates of the 44° and 37·5° observations, the transit time of *M*31 was sufficiently early in the evening for interference to be experienced on most nights from frequency-modulation broadcasting stations. Accordingly, only a few good profiles were obtained at these declinations.

The minimum signal that can be detected by our radio telescope corresponds to a randomly polarized incident intensity of about 7×10^{-26} W m $^{-2}$ (c /sec)$^{-1}$ for a single record. The maximum observed intensity of *M*31 (near R.A 00h. 40m) is about $2·5 \times 10^{-25}$ W. m.$^{-2}$ (c /sec.)$^{-1}$. This includes both polarizations. The total intensity is about four times this value, which makes the total radio intensity of *M*31 at 250 Mc /sec. approximately equal to 10^{-24} W. m $^{-2}$ (c./sec)$^{-1}$. Hanbury Brown and Hazard[2] found the same total intensity at 159 Mc /sec. It might be expected that the intensity of *M*31 at 250 Mc./sec. would be approximately 0·63 (= 159/250) as much, instead of the same value However, this may be explained by integration over a larger source area in the present case.

I am indebted to Geoffrey Keller for helpful discussions and to Donn Van Stoutenburg and Gabriel Skitek for assistance in improving the telescope receiver The radio telescope project is supported by grants from the Development Fund, the Lovejoy Memorial Fund, and the fund for basic research of the Ohio State University and also by a grant from the National Science Foundation [Nov 4

---

[1] Ryle, M , Smith, F G , and Elsmore, B , *Mon Not Roy Astro Soc* , 110, 508 (1950)

[2] Hanbury Brown, R and Hazard, C , *Mon Not Roy Astro Soc* , 111, 357 (1951)

[3] Kraus, J D , Ko, H C , and Matt, S , *Astro J* , [59, 439 (1954)]

[4] Williams, R C , and Hiltner, W A , *Pub Obs Univ of Mich* , 8, 103 (1943)

[5] Baade, W , Lect 8, Symp on Astrophys , Univ of Mich (1953).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Lung Injury by Impact with a Water Surface

Medical findings during the inquiry into the recent *Comet* disasters have suggested that the possibility of lung damage by impact with a water surface at the terminal velocity of fall (about 160 ft /sec) should be investigated It is known from observations on the effects of explosive blast that severe lung damage occurs when the impulse communicated to the chest wall exceeds a certain limit Penney and Bickley (unpublished report, Min of Home Security, 1943), after a study of the work of Zuckerman and his collaborators[1] on blast injury, suggested that the lungs of man or any animal would be severely injured by transmission of the shock wave set up if the chest wall were flung inwards with a velocity of 20 m /sec (66 ft /sec) acquired in 0 5 m sec. or less

Work by E G Richardson[2] on the impact of rigid spheres with a water surface may be applied in an attempt to estimate the velocity of impact which might be expected to produce the chest-wall motion specified by Penney and Bickley as being critical. Richardson measured the variation with time of the force of impact, showing that it rises to a peak and becomes relatively small again by the time semi-immersion has been reached He found his results to be reasonably consistent with the assumption that at any particular instant the sphere carried with it an 'added mass' of water equal to that in a hemisphere erected on the wetted perimeter

In applying this method of calculation to a non-rigid body, such as the chest of an animal, it will be assumed first that only the motion of that part actually in contact with the water is modified by the impact, this appears reasonable for the relatively small displacements of the chest wall visualized by Penney and Bickley. Assuming further that the chest is a sphere (radius a) and that the radius of the wetted perimeter is c at the instant considered, conservation of momentum between the part of the chest wall immersed and the 'added mass' of water gives approximately

$$\pi c^2 \mu V = \pi c^2 \mu v - \tfrac{2}{3}\pi c^3 \rho v$$

where V is the incident velocity, v is the velocity of the immersed part of the chest wall of mass μ per unit area, and ρ is the density of the liquid. The inward velocity of the immersed part of the chest wall with respect to the rest of the body must be $V - v$ $(= v_c)$, so that the above equation becomes

$$V/v_c = 1 + 3\mu/2c\rho \qquad (1)$$

If v_c be taken as 66 ft./sec., the corresponding value of V should then be the critical velocity of impact for severe lung damage, according to Penney and Bickley's ideas

Apart from the approximations made in its deduction, equation (1) can only provide a very rough estimate of the critical velocity of impact for a given animal, because the result of any calculation must depend on the value of c chosen to correspond to a significant area of contact with the water If the value $a/\sqrt{2}$ be arbitrarily assigned to c (that is, πc^2 is half the total area of cross-section) the critical velocity of impact is 99 ft./sec for a guinea pig ($\mu = 0$ 7 gm /cm ^{2}, $a = 3$ cm), 118 ft /sec. for a mous ($\mu = 0$ 3 gm /cm ^{2}, $a = 0$ 8 cm) and 94 ft /sec. fo a man ($\mu = 3$ gm./cm ^{2}, $a = 15$ cm). In each cas the body is assumed to be of similar shape, offerin a similar aspect to the water surface at the momen of impact, and the possibility of protection by thic fur, limbs or clothing has been neglected. The value of μ and a cannot be chosen very precisely, but th critical velocity, as calculated by equation (1), is o the same order for a wide range of size of anima because both μ and a should be roughly proportiona to the cube root of body-weight

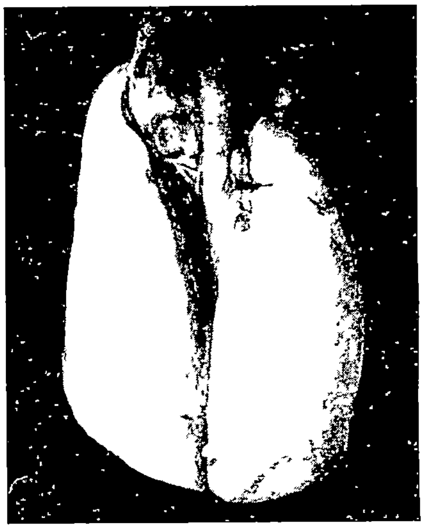


Fig 1 Lungs of a normal guinea pig killed with ether

That the effective 'blow' should be delivered whil the body descends through a distance fairly smal compared with a seems to be a reasonable assumptio on the basis of Richardson's work. Penney an Bickley's 'time' condition, that the stipulated chest wall velocity be acquired in 0 5 m.sec or less, shoul then be easily satisfied in the cases of the guinea pi and the mouse falling at 99 and 118 ft./sec. respectively For man, however, the position in this respec is more doubtful, at a rate of fall of 94 ft./sec the distance moved in 0 5 m.sec. is 1 5 cm, or onl 10 per cent of the value taken for a.

Some animal experiments were devised for testin the validity of these deductions. A vertical catapul was specially constructed for projecting guinea pigs belly first, into a large tank of water. Differen velocities were used, from 66 to 117 ft /sec Si animals were anæsthetized with ether, and four other were killed (as judged by respiratory arrest) som ten minutes before the experiment. Controls kille with ether showed no pulmonary pathology (Fig. 1) and lesions of only a trivial nature resulted fron projection into cotton wool at about 100 ft /sec.

Grave injury to the lungs, and other viscera, wa found in animals projected into water at velocitie greater than 104 ft./sec , both anæsthetized and dea specimens giving the same result. The effect wa diffuse pulmonary concussion, quite similar to tha of blast injury[1,3]. Confluent sub-pleural hæmorrhage were conspicuous (Fig 2), and in places presented linear pattern of 'rib markings'. Patches of sub pleural emphysema and occasional lacerations wer also found. Microscopically, there were structura changes throughout the lungs, the lower and middl

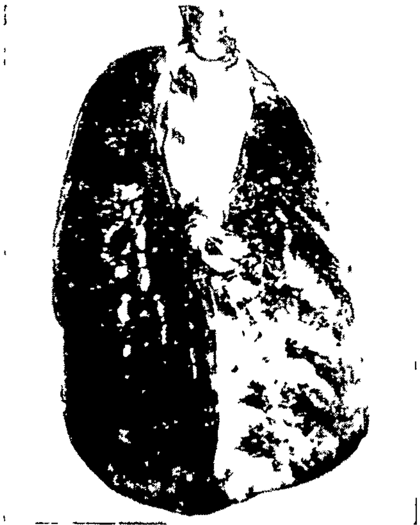


Fig 2 Lungs of a guinea pig projected into water at 107 ft /sec

obes being chiefly affected The predominant lesions vere hæmorrhagic consolidation, patchy atelectasis, nd traumatic emphysema amounting in places to avitation.

At slightly lower velocities, similar but more ocalized lesions occurred, and at less than 75 ft /sec he lungs were unaffected but for a few small subleural ecchymoses The living animals were all illed by the impact, even at the lower velocities, nd in no case was there evidence of death by rowning

These experiments, though few in number, indicate hat lung damage can result from impact with a vater surface at high incident velocities. The critical elocity for severe injury in the guinea pig would ppear to be consistent with the predicted value, ut the closeness of the agreement must be regarded s largely fortuitous in view of the approximate ature of the calculations

We are indebted to Squadron Leader P Howard, light Lieutenant D I Fryer and Mr. N. L Andrews or help and advice with the experimental work. ur thanks are also due to Sir William Penney for llowing us to quote from unpublished work, and to he Director-General of Medical Services, R A.F, for ermission to publish this communication

W. K Stewart
K. E. Spells
J. A. Armstrong

.A.F. Institute of Aviation Medicine,
Farnborough, Hants.
Jan. 19.

Zuckerman, S, *Lancet*, i, 219 (1940) Krohn, P L, Whitteridge, D and Zuckerman, S, *Lancet*, i, 252 (1942)
Richardson, E G, *Proc Phys Soc*, 61, 352 (1948)
Clemedson, C J, *Acta Physiol Scand*, 18, Supp 61 (1949)

Crystalline-like Patterns in the Nuclei of Cells infected with an Animal Virus

A GROUP of viruses causing very peculiar changes f the infected cells in tissue cultures was recently solated in our laboratory[1]. The strains were obtained rom cases of either mesenteric lymphadenitis or haryngitis with cervical lymphadenitis. An apparntly identical microscopical picture[1] was caused by gents described by Neva and Enders[2] and Hilleman and Werner[3]. So far, all strains exhibiting this pattern of cytopathic activity which have been tested in our laboratory have had complement-fixing antigens in common, although by neutralization tests they could be differentiated into three types[1].

The ultra-structure of cells infected with one of our strains (*L O*.4574/54, isolated from a mesenteric lymph node) was studied by electron microscopy HeLa cells[4] were grown in stationary culture tubes on a piece of plastic placed at the bottom. This support for the cells was sliced from a piece of the plastic employed for embedding. Any toxic influence was removed by autoclaving in large amounts of distilled water. The specimens for sectioning were prepared by a modification of methods previously described[5] For fixation the pieces of plastic with their layer of cells were immersed in a 1 per cent solution of osmic acid (buffered at *p*H 7 2) for 30 min. at a temperature of 0° C They were then embedded in a methacrylate mixture The microtome devised by Sjostrand[6] was used for sectioning

Figs 1 and 2 reveal the picture within cells infected 48 hr earlier with the *L O.* strain A tissue culture

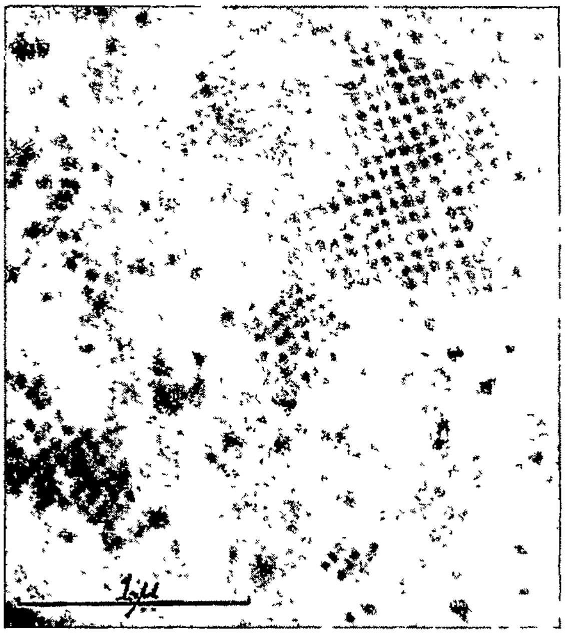


Fig 1

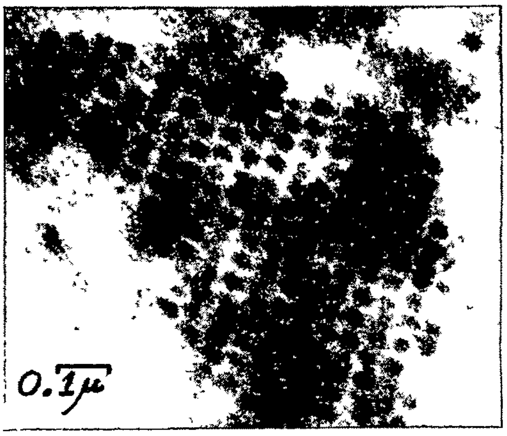


Fig 2

fluid filtered through a bacteria-retaining glass filter was used as inoculum in a dose corresponding approximately to $10^{5 \cdot 5}$ ID_{50} per 10^5 cells. Most nuclei in the sections of infected cultures contained crystalline-like patterns consisting of particles which usually appeared somewhat elongated and measured up to approximately 50 mμ × 30 mμ. These formations were seen more regularly and were often larger 48 hr. after infection than 24 hr. after infection. No similar patterns or particles were seen in sections of non-infected cultures or cultures infected with polio-myelitis virus type 1 (some of these experiments were carried out in co-operation with Dr. Aksel Birch-Andersen and Dr. Fritiof Sjöstrand)

In the preparations so far studied the cytoplasmic structure of cells with intranuclear 'crystals' appeared largely unchanged. This seemed to be in contrast to our findings in cells infected with poliomyelitis virus type 1 (strain *RC*), where cytoplasmic changes were obvious

Lars Kjellén
Gosta Lagermalm
Arne Svedmyr
Karl-Gustaf Thorsson
Municipal Central Bacteriological Laboratory,
Box 177, Stockholm 1.
Jan. 11.

---

[1] Kjellén, L , *Arch ges Virusforsch* (in the press)

[2] Neva, F A , and Enders, J F , *J Immunol*, 72, 315 (1954)

[3] Hilleman, M R , and Werner, J H , *Proc Soc Exp Biol and Med*, 85, 183 (1954)

[4] Scherer, W F , Syverton, J T , and Gey G O , *J Exp Med*, 97, 695 (1953)

[5] Palade, G E , *J Exp Med*, 95, 285 (1952) Newman, S B , Borysko, E., and Swerdlow, M , *J Res Nat Bur Stand* , 43, 183 (1949)

[6] Sjöstrand, F S , *Experientia*, 9, 114 (1953)

Effect of Injections of Œstrogen on the Mast Cells of the White Mouse

There is no agreement on the connexion which may exist between mast cells and the function of endocrine glands It is known that the number of mast cells increases during hypothyroidism[1] and becomes normal in the hypothyroid subjects treated with thyroxin , it is also known that the number of mast cells in the rat and in the white mouse undergoes, under the influence of cortisone, a considerable increase, particularly in the interlobular connective tissue of the thymus, in the lymph nodes and in the bone-marrow[2]. A study of the behaviour of mast cells during other modifications of the endocrine equilibrium should thus be opportune.

Adult white mice, six males and six females, of a stock maintained in this laboratory for several years, were given daily injections of 100γ of dihydrofolliculine benzoate ('benzogynœstryl Roussel') , three animals of each sex were autopsied the day after the third injection and the three others of each sex were killed the day after the sixth injection Samples of tissues were fixed in Bouin's fluid, sectioned from paraffin and stained with polychrome blue, Mann–Dominici or cresyl violet–picrofuchsine

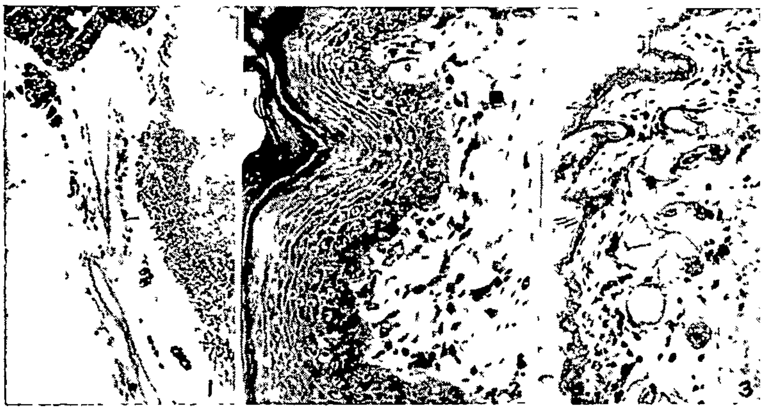


Fig 1 Salivary gland, top, at left , the cortex of lymph node to the right with connect ive tissue of excretory canal extremely rich in mast cells Bouin–Dominici

Fig 2 Vaginal epithelium with numerous mast cells in the dermis Bouin-polychrome blu

Fig 3 Subcutaneous connective tissue from the perineal region with a superabundanc of mast cells Bouin–cresyl violet–picrofuchsine

Examination of sections revealed a considerabl increase in the number of mast cells in all the organ studied . lymph nodes, thymus, visceral connectiv tissue (salivary glands (Fig. 1), intestine, genit organs (Fig 2)) and a very great increase in th subcutaneous tissue (Fig 3). The increase in numbe of mast cells and the influence of œstrogenic hormon is, as a rule, less in the male mouse than in the femal

This increase in the number of mast cells different from that described in the general syndrom of adaptation, either after injections of alloxan[3], c after irradiation with X-rays[4], because it is generalize and not limited to hæmopoietic organs. By it generalized effect, this increase in mast cells (labrc cytosis) recalls that of hypothyroidism

It is possible that a thyroid mechanism is implicate in determining the labrocytosis provoked by œstrc gens It is known that folliculin is an antagonist c thyroxin on certain hormone-sensitive organs, a for example, during the growth of the uterus in th ovariectomized mouse[5], or on the tubular segmer of the submaxillary gland of the mouse[6]. Th interpretation would explain the observation th labrocytosis is less marked in male mice treated wit œstrogen than in females

Lucie Arvy
Laboratoire d'Anatomie et Histologie
comparées de la Sorbonne,
Paris
Nov. 16

---

[1] Arvy, L , and Gabe, M , *Experientia*, 6, 23 (1950) Arvy, L , Debra Ch , and Gabe, M , *Arch Mal App Digest* , 39, 943 (195 Asboe-Hansen, G , *Bull Hist App* , 27, 5 (1950)

[2] Arvy, L , Boiffard, J A , and Gabe, M , *C R Soc Biol* , 146, 15 (1952)

[3] Arvy, L , and Gabe, M , *Rev Hémat* , 4, 519 (1949)

[4] Arvy, L , Boiffard, J A , and Gabe, M , *C R Acad Sci* , *Paris*, 23 1022 (1951)

[5] Arvy, L , *Le Sang*, 16, 198 (1944)

[6] Arvy, L , and Gabe, M , *C R Acad Sci* , *Paris*, 230, 2333 (1950).

Effect of Growth Hormone on the Large Particle Content of Rat Liver

In the course of an investigation[1] of rat liver, wi respect to hormonal effects on the yield and cor position of fractions isolated by differential centi fugation in 0 25 *M* sucrose medium[2], determinatio have been made of the particle number in fresh isolated 'large-particle' ('mitochondrial') fraction

These fractions were obtained from liver homogenates, prepared with a Potter-type homogenizer and centrifuged at a low speed to remove 'debris' containing the nuclei, by further centrifugation for 20 min. in an 'Angle 13' (Measuring and Scientific Equipment, Ltd) centrifuge at 12,000 *g* (maximum value, at extreme tip of tube) The particles were suspended in 1 8 *M* sucrose solution and counted under dark-ground illumination as described by Allard *et al*[3] Under these conditions (in 1 8 *M* sucrose) the particle size-range is decreased (compressed), all visible particles up to and including the mitochondrial size-range were counted.

The study included hypophysectomized albino male rats of about 200 gm. weight, some of which had received daily injections of 0 3 mgm of pituitary growth hormone (presented by Armour and Co, Chicago) for eight to twelve days. The effect of adrenalectomy was also studied, with albino females of about 250 gm weight, given saline in place of drinking water The rats were arranged in groups, such that the experimental rats were compared with control rats (intact or sham-operated) which had been kept on the same food intake, and which were killed on the same day after an overnight fast

As shown in Table 1, there was a marked increase in 'large-particle number' with hypophysectomized rats given growth hormone. The absence of any significant change with untreated hypophysectomized or adrenalectomized rats suggests that there may be some pituitary hormone, other than adrenocorticotrophin, which has an influence converse to that of growth hormone on particle number. As reported elsewhere[1], hypophysectomy or adrenalectomy slightly diminishes the weight yield of the 'large-particle' fraction, and on administration of growth hormone to hypophysectomized rats the weight yield shows an increase which is, however, considerably smaller than the increase in number now reported.

Table 1 PARTICLE COUNTS ON 'LARGE-GRANULE' FRACTIONS ISOLATED FROM RAT LIVER

Hormonal status*	Particle number†, as per cent of that for control rats studied simultaneously (values calc as No /100 gm body-weight)
Hypophysectomized	123 ± 17 5 ($n = 5$)
Hypophysectomized + growth hormone	371 ± 25 7 ($n = 6$, $P \leqslant 0\ 1\%$)
Adrenalectomized	116 ± 39 0 ($n = 5$)

* Operated animals were killed two to three weeks after operation
† Mean ± stand error, *n* denotes number of observations, and *P* the probability that difference from controls could be due to chance

Acknowledgment is made to the Agricultural Research Council for the award of a grant (A L G and T. F S), and to the British Empire Cancer Campaign for the award of a Junior Fellowship (E R)

A L. GREENBAUM
T. F. SLATER

Biochemistry Department,
University College,
London, W C 1

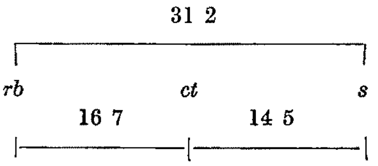
E REID

Chester Beatty Research Institute,
Institute of Cancer Research ·
Royal Cancer Hospital,
London, S W.3
Nov 12

Reid, E, (*a*) *Biochem J*, 58, xxiii (1954), (*b*) Proc Symp on "The Hypophyseal Growth Hormone" (Henry Ford Hospital, Detroit) (to be published), (*c*) *Nature*, [175, 461 (1955)]
Schneider, W C, *J Biol Chem*, 176, 259 (1948)
Allard C, Mathieu, R, de Lamirande, G, and Cantero, A., *Cancer Research*, 12, 407 (1952)

The Hypothesis of Chromosomal Interference

IT has been known for a long time that both chromatid and chromosomal interference produce similar effects on recombinations recovered in classical genetical (Mendelian) analysis in which single chromatids are sampled Although deviations from a unitary coincidence are probably due either to chromatid or chromosomal interference, the classical method does not permit one to determine whether one or the other, or both, processes are effective in producing the deviations It is strange, therefore, that chromosomal interference has been the accepted explanation of non-unitary coincidence since the very beginning of modern genetical analysis. The utility of either hypothesis in the analysis of single-chromatid experiments may be demonstrated by considering the following map



The expected frequency of double-recombinations would be 16 7 × 14 5 × 10^{-4}, or 2 4 per cent, whereas the actual frequency is only 0 9 per cent. The accepted conclusion has been that one cross-over actually interferes with the occurrence of another, the 'strength' of this interference being indicated by the coincidence value (in this case, 2 67) The hypothesis of chromatid interference is, however, equally applicable if one supposes that adjacent cross-overs form four-strand double exchanges at a frequency equal to or greater than 72 per cent.

Tetrad analysis provides an opportunity of discriminating between these two types of interference. The only positive data on this subject may be summarized as follows

(1) Negative chromosomal interference exists in *Neurospora*[1], that is, the presence of one cross-over 'facilitates' rather than inhibits the occurrence of another

(2) A mapping function which assumes a Poisson distribution of the number of cross-overs has produced additive distances in the otherwise non-additive recombination data in yeast, indicating that cross-overs occur independently of one another in these regions (C C. Lindegren and E E Shult, to be published)

It is clear from these findings that the existence of chromosomal interference has been neither demonstrated nor proved.

This work has been supported by research grants from Anheuser-Busch, Inc., and the National Cancer Institute of the National Institutes of Health, Public Health Service

ERNEST E. SHULT
CARL C. LINDEGREN

Biological Research Laboratory,
Southern Illinois University,
Carbondale, Illinois.
Sept 24.

---

[1] Lindegren, C C, and Lindegren, G, *Genetics*, 27, 1 (1942) Comments following Perkins, D D, Biology Research Conference on Genetic Recombination, Oak Ridge National Laboratory (1954)

Crystalline Trypsin Inhibitors from the Indian Field Bean and the Double Bean

While studying the digestibilities of some Indian pulses, Gaitonde and Sohonie[1], from this laboratory, reported the detection of a trypsin inhibitor in field bean, *Dolichos lablab*. Since then, Sohonie and collaborators[2] have surveyed various Indian foodstuffs for the inhibitory factor and studied their properties in general. The field bean was found by them to be a fairly rich source of this principle and, as a continuation of their work, a simple method by which the trypsin inhibitor from field beans is obtained in a crystalline form is described here Kunitz[3], Bowman[4], Tauber and co-workers[5] have isolated similar crystalline preparations from different plant materials such as soybean, navy bean and lima bean respectively

1,000 gm of defatted field bean meal was extracted with 5,000 ml. of 0 25 *M* sulphuric acid at 25–28° C for 1 hr with occasional stirring The suspension was centrifuged and the residue rejected. The supernatant was saturated with magnesium sulphate and the precipitate separated This was taken up with 500 ml of 2 5 per cent trichloracetic acid and heated in a boiling water-bath for 5 min The suspension obtained was suddenly chilled in an ice-bath and filtered The filtrate was saturated for the second time with magnesium sulphate and centrifuged The residue was dissolved in 100 ml water and dialysed in a 'Cellophane' bag in a running stream of water. After about 20 hr, the contents of the bag, free from magnesium and sulphate ions, were centrifuged and the supernatant was precipitated by four volumes of cold acetone The acetone precipitate was separated by centrifugation and dissolved in a minimum quantity of water and lyophilized The yield was about 1 5 gm

This material has a light straw colour, is very easily soluble in water and shows a strong inhibitory action on trypsin. When to the aqueous solution 1 *M* sulphuric acid was added drop by drop until a faint turbidity appeared, and this was allowed to stand at room temperature, long needle-shaped crystals, visible under the microscope, were formed within a short time (Fig 1) This inhibitor gave a strong biuret reaction and was found to contain 13 6 per cent nitrogen

With the view of evaluating the potency of the preparation, the effect of different concentrations of it on trypsin was studied. Digestion tubes with various amounts of the field bean inhibitor and a constant quantity of the enzyme at 7·6 *p*H were kept for preliminary incubation for 10 min. at 37° C The skimmed milk substrate was then added and the tubes were further incubated for 10 min. The extent of inhibition was determined by Anson's[6] colorimetric method Proper controls were run simultaneously. The results are presented in Table 1.

Table 1 Effect of Field Bean Inhibitor on Trypsin (Merck)

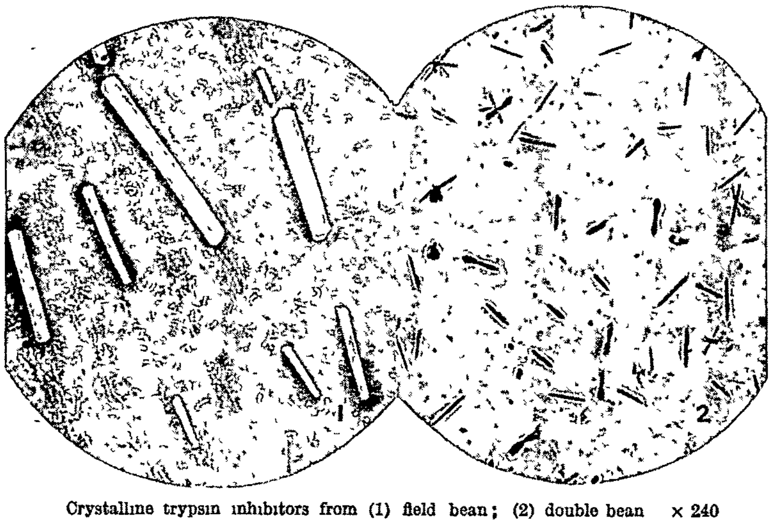
Trypsin in each tube 5 mgm
Skimmed milk in each tube 150 mgm
Volume of the reaction mixture 5 ml

Concentration of the inhibitor (mgm)	Inhibition (per cent)
5	100
2 5	100
1 25	97
0 5	82

It will be seen that the field bean preparation exerts a strong inhibitory action on trypsin, as it almost completely inhibits four times its weight of the enzyme. Similar results obtained by Laskowski; Mars and Laskowski[7], Fraenkel-Conrat and others and Viswanatha and Liener[9] using crystalline trypsin with trypsin inhibitors from other sources show that the proportion of the inhibitor to trypsin for complete inhibition of the latter varies from 0 78 in the case of ovomucoid inhibitor to 2 65 in the case of Kazal pancreatic inhibitor. Whether the higher activity obtained for the field bean inhibitor as compared to that of the crystalline trypsin inhibitors mentioned is due to the fact that non-crystalline trypsin (Merck) was used in the present investigation is now being studied

Subjecting double bean (*Faba vulgaris*) flour to a similar treatment, a trypsin inhibitor was prepared by using ammonium sulphate instead of the magnesium salt An alternative method consisting of the extraction of the double bean meal directly with 2 5 per cent trichloracetic acid, heating the suspension and removal of the inhibitor in the filtrate subsequent dialysis, acetone, precipitation of the inhibitor from the supernatant followed by lyophilization, also gave a similar material The yield was 0 25 gm /100 gm. of the bean flour. Fine needle shaped crystals clustered together were obtained on treating this lyophilized powder in a similar manner with 1 *M* sulphuric acid (Fig 2) The double bean preparation is chalk-white, extremely soluble in water and shows a strong inhibitory action on trypsin, one part wa found to inhibit completely five parts of Merck trypsin powder The double bean inhibitor was remarkably heat-stable As much a 95 per cent of the inhibitory activity was retained even afte autoclaving at 15 lb for 30 min The preparation contained 12 pe cent nitrogen When tested qualitatively, it gave strong biuret and tryptophan reactions and a positive Molisch test

Further studies on the composition, physico-chemical properties, etc, are in progress and will b published elsewhere We are indebted to the Council of Scientifi and Industrial Research for finan



Crystalline trypsin inhibitors from (1) field bean; (2) double bean × 240

ial assistance and a personal grant to one of us K. S. A) We are also grateful to Dr K R Dixit for the photomicrographs

KAMALA SOHONIE
K S AMBE

Department of Biochemistry,
Institute of Science,
Bombay 1.
Dec. 2.

Gaitonde, M K, and Sohonie, K, *Curr Sci*, 20, 217 (1951)
Gaitonde, M K, and Sohonie, K, *J Sci Ind Res*, 11 339 (1952) Sohonie, K, and Bhandarkar, A P, *J Sci Ind Res*, 13B 500 (1954)
Kunitz, M, *J Gen Physiol*, 30, 291 (1947)
Bowman, D E, *Arch Biochem*, 16, 109 (1948)
Tauber, H, Kershaw B B, and Wright, R D, *J Biol Chem*, 179, 1155 (1949)
Anson, M L, *J Gen Physiol*, 22, 79 (1938)
Laskowski, jun, M, Mars, P H, and Laskowski, M, *J Biol Chem*, 198, 745 (1952)
Fraenkel-Conrat, H, Bean, R S, Ducay, E D, and Olcott, H S, *Arch Biochem Biophys*, 37, 393 (1952)
Viswanatha, T, and Liener, I E, *J Biol Chem*, 210, 97 (1954)

An Effect of Certain Proteins and Amines on Prostatic Acid Phosphatase

HIGH dilutions of seminal fluid in physiological saline often show markedly lower acid phosphatase activity than similar dilutions of the same specimen n serum or serum derivatives[1]. This difference is especially marked in specimens which have been stored for some days or weeks in the refrigerator Similar differences may be found between the acid phosphatase activity of saline extracts of human prostate diluted with saline and those diluted with erum derivatives

It was found that by the addition of gelatine it is possible to maintain phosphatase activity in saline-diluted seminal fluid as effectively as in the presence of serum. Fig 1 shows the curve of acid phosphatase activity of highly diluted seminal fluid in samples containing different concentrations of gelatine Results are expressed as a percentage of the activity obtained in the presence of 50 mgm gelatine/100 ml

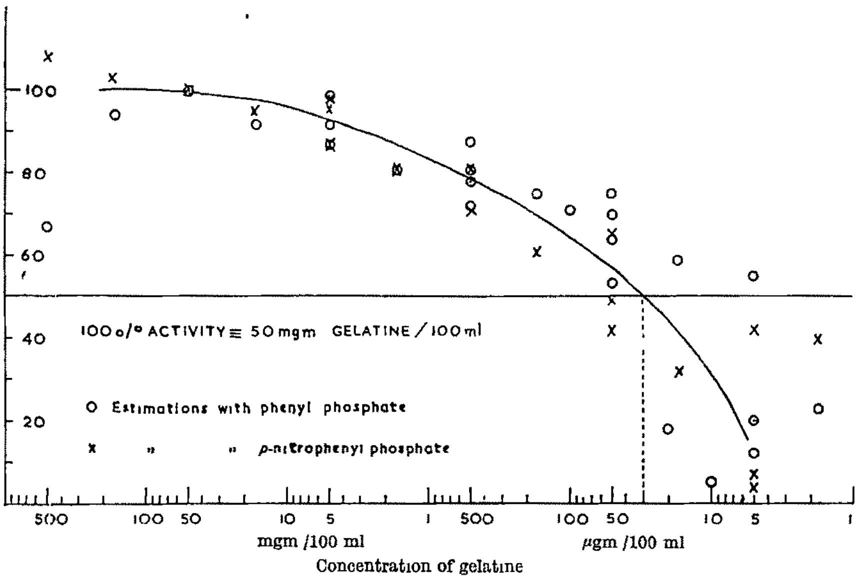


Fig 1

The specimens which were used for these experiments showed in complete absence of gelatine less than 20 per cent, and usually less than 10 per cent, activity At a concentration of approximately 30 μgm gelatine/100 ml the activity was about half that obtained in the presence of 50 mgm gelatine/100 ml.

The concentration of any substance required to give half the activity shown by a sample containing 50 mgm gelatine/100 ml in any given preparation of prostatic phosphatase was taken as a constant of activity, *A*, for the comparison of different substances *A* expressed in μgm /100 ml. was 30 for gelatine, 50 for blood albumin, 21 for salmine sulphate and 20 for clupein sulphate A similar effect was found with a number of amino-compounds, but far greater concentrations were required for comparable activity The values of *A* for some of these substances, expressed in millimoles/litre, were as follows ethylamine, 143, ethylene diamine, 7, trimethylene diamine, 11, tetramethylene diamine, 6 7, pentamethylene diamine, 4 5, hexamethylene diamine, 0 19, spermidine (NH_2 $(CH_2)_3$ NH $(CH_2)_4$ NH_2), 0 15, decamethylene diamine, 0 08, spermine (NH_2 $(CH_2)_3$ NH $(CH_2)_4$ NH $(CH_2)_3$ NH_2), 0 03, and 'Synthalin *A*' (NH_2 (NH)C NH (CH_2)10 NH C(NH) NH_2), 0 015

The effect is seen to increase with the chain-length between terminal amino-groups. It is not decreased by the formation of benzyl or dinitrophenyl derivatives, but is completely destroyed by acetylation Amides and α-amino-acid groupings are inactive malonamide is completely inactive up to a concentration of *M*/10, whereas trimethylene diamine shows half activity (*A*) at *M*/90, histidine and tryptophan are both inactive (at *M*/10 and *M*/100, respectively), but histamine and tryptamine each have a value of *A* of about *M*/200 Arginine has a slight effect, with a value of *A* about *M*/17, but this can be attributed entirely to the guanidino group, as the value of *A* for guanidine is about *M*/20 Ornithine also shows a slight effect, but less than that of ethylamine, none was found for lysine, asparagine, citrulline, serine or glycine, up to a concentration of *M*/10

The action of gelatine is not significantly reduced by peptic digestion, but is very markedly reduced by digestion with trypsin or papain (the digestive enzyme was inactivated by boiling carried out before the test), and is completely destroyed by hydrolysis with 8 *N* hydrochloric acid This supports the hypothesis that the effect of proteins and peptides is related to the amino-groups of basic side-chains, linked through the peptide chain to produce an effect similar to that of the long-chain polyamines

The effect described appears to be due to a protective action of these substances which prevents inactivation of the enzyme on extreme dilution, since addition of gelatine after the start of incubation fails to restore acid phosphatase activity This destruction or denaturation of the enzyme would appear to be an immediate outcome of the final dilution in the substrate mixture, due perhaps to surface denaturation by the glass tubes, as suggested by London and Hudson[2] Curves for enzyme activity are linear, both in the presence of protective substances as well as in their absence when activity is at the minimum

I thank the British Empire Cancer Campaign for the grant which supported this work, and Evans Medical Supplies, Ltd, for the gift of 'Synthalin A'

GRACE M JEFFREE

University of Bristol
Pathology Research Laboratory,
18 Guinea Street, Bristol 1

---

[1] Jeffree, G M, *Biochem J*, 53, xv (1953)

[2] London, M, and Hudson, P B, *Arch Biochem and Biophys*, 46, 141 (1953)

Detection of Vascular Tissues available for Water Transport in the Hop by Colourless Derivatives of Basic Dyes

In the course of a study of the host–parasite relations in *Verticillium* wilt of the hop, it has been observed that infection of the vascular system by the pathogen is frequently accompanied by the development of numerous tyloses, and that a considerable proportion of the vascular elements in a diseased plant may thus be rendered useless for the passage of water

The extent of such obstruction in the vascular cylinder as a whole is not readily determined by examination of transverse sections, for the absence of tyloses in certain vessels in the plane of the section does not preclude the possibility that they may be present in those same vessels at levels above or below that of the section. A more satisfactory method is to allow the plant to take up an aqueous solution of a dye which will stain permanently any vessels through which it passes Sections prepared afterwards will then give a clear indication of the parts of the wood available for water transport

A number of stains at a concentration of 0 1 per cent in water were introduced into hop plants by petiole injection following the methods of Roach[1], and also by severing the stem at soil-level and inserting the cut end in a tube of the solution It was found that acidic dyes, for example acid fuchsin, light green and eosin, travelled freely in the plant but diffused from the vascular elements into neighbouring tissues and in subsequent processing were more or less completely removed from the vessel walls

Basic dyes such as malachite green, methylene blue, safranin, crystal violet and basic fuchsin stained lignified tissues deeply but were far less mobile than the acidic types Basic fuchsin or crystal violet applied by petiole injection travelled only a few millimetres from the point of application and induced wilting Thus none of the stains tested was suitable for the purpose, although it should be noted that in some other species, for example tomato, basic fuchsin was found to travel slowly but extensively, and little wilting occurred until the plant had become fairly generally injected

Satisfactory results with hop plants were finally achieved by the use of colourless forms of basic fuchsin and crystal violet derived by treatment of the dyes with sodium metabisulphite 10 per cent aqueous sodium metabisulphite was added slowly an with vigorous shaking to 100 ml of 0 1 per cen solution of basic fuchsin or crystal violet in wate (B D H. Standard Stains) until the dye was almos completely decolorized This required approximately 5 0 ml. of metabisulphite for basic fuchsi and 10 0 ml for crystal violet A faint residu colour appeared to have no undesirable effect, an a considerable volume of metabisulphite solution wa required to remove it entirely

Application of such solutions through the base c the stem or by petiole injection led to intense staining of the vascular elements in the immediat vicinity within 1–3 mm, and the stain was transported throughout the vascular system of a health plant at a rate comparable with that of the mobil acidic dyes

Sections cut from the stained material wer counter-stained with 1 per cent light green in 95 pe cent ethanol and dehydrated for preparation c permanent mounts without loss of stain from th vessel walls

Short segments of the stem were treated with hc 15 per cent nitric acid for 5–15 sec to remove ep dermal and cortical tissues, dehydrated in ethan and cleared in clove oil for preservation as permaner whole-mounts

The basic fuchsin derivative appears to be relativel non-toxic, and it is possible that it might be used i growth studies for 'marking' vascular tissues *in situ* i growing plants The method may also be useful i anatomical studies of, for example, the structure c the nodal regions of shoots

P W TALBOYS

East Malling Research Station,
Maidstone, Kent
Dec 1.

---

[1] Roach, W A, Imp Bur Hort and Plant Crops, Tech Comm, : (1938)

Role of Sulphydryl Groups in the Long-range Elasticity of Wool

Fibres of wool and hair may be stretched nearl 100 per cent in water at room temperature, and the return to their original lengths on being release If a fibre is stretched more than about 30 per cen or if stretched very slowly to any extension and the released, subsequent stretching requires less energ indicating that an irreversible change has taken place In explanation of these effects it has been postulate that hydrolysis of disulphide bonds occurs durin stretching to give sulphydryl and sulphenic-aci groups, but direct evidence for the production c either of these in wool or hair is lacking[2,3].

A sensitive colorimetric method for estimatin sulphydryl groups in wool, based on that of Va Scott and Flesch[4], has now been developed, and fu details of the method and results will be reported els where Tests on samples of merino wool before an after stretching to about 60 per cent in water a room temperature have not revealed any increase i the number of sulphydryl groups on stretching, thu suggesting that hydrolysis does not play a large pa in the stretching of wool under these conditions. A alternative explanation, based on the fact that wo fibres contain small amounts of free sulphydr groups[5] and that they are difficult to stretch in aci solution[3], is as follows

If, during the stretching of a wool fibre, a sulphydryl group comes into contact with a disulphide bond, reduction may occur with the formation of a new sulphydryl group and a new disulphide bond

$$R^1{-}CH_2{-}SH + R^2{-}CH_2{-}SS{-}CH_2{-}R^3 = R^2{-}CH_2{-}SH + R^1{-}CH_2{-}SS{-}CH_2{-}R^3$$

$$\text{or} = R^3{-}CH_2{-}SH + R^1{-}CH_2{-}SS{-}CH_2{-}R^2,$$

where *R* is part of a polypeptide chain. Since the ibre is under tension, the new disulphide bonds will end to be such that they do not oppose stretching, o that in a stretched fibre some of the disulphide bonds will have been rearranged, with the elimination of those that opposed stretching Unless these are re-ormed during contraction, subsequent extensions of he fibre after release will be easier, although the number of disulphide bonds and sulphydryl groups will be unchanged Sulphydryl–disulphide interchanges in solution have been reported for simple peptides[6], ovalbumin[7] and bovine plasma albumin[8]

According to the above mechanism, wool fibres with no free sulphydryl groups should be more difficult to stretch than usual Fig 1 shows part of the elongation of three groups of merino fibres—purified oot ends from one staple of wool *E6N*—under a oad of 6 × 10⁵ gm per cm.[2] cross-section at 25° neasured by the direct loading method[9]. Fibres of group *A* were treated for four days with a 0 05 *M* olution of N-ethylmaleimide in *p*H 7 4 phosphate buffer to block sulphydryl groups , those of group *B* were treated for the same time with the buffer solution only , while those of group *C* were untreated Fibres of group *A* and group *B* were stretched in water and those of group *C* in 0 1 *N* hydrochloric acid There is little difference during the initial rapid xtension to about 37 per cent , but beyond this, he fibres of group *A*, which had been treated with N-ethylmaleimide, stretched at a much slower rate han those of group *B*, which had not been treated with this reagent, and, in fact, were almost as slow as the fibres stretched in acid (group *C*) Similar esults were obtained if iodoacetamide or mercuric chloride were used in place of N-ethylmaleimide. With he possible exception of mercuric chloride, these eagents should not be able to form new cross-links in the fibres, so the slower rates of stretching are presumably due to inhibition of sulphydryl–disulphide interactions.

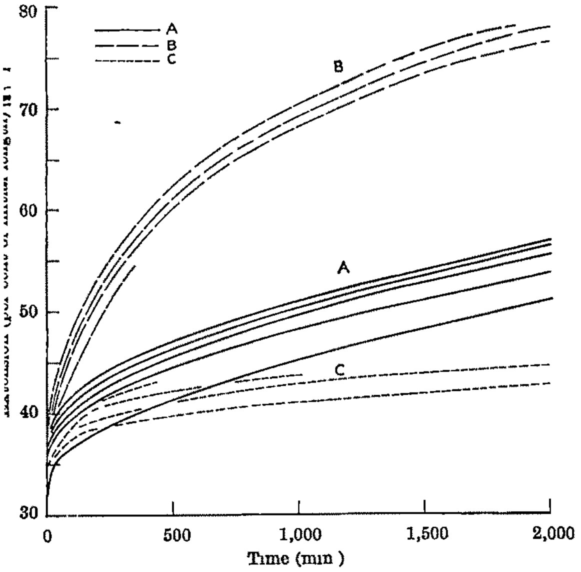


Fig 1

It is possible that this process has a wider application in wool chemistry For example, it appears to play some part in supercontraction by means of phenol The supercontraction of merino fibres (from sample *E9N*) after boiling for 10 min in 50 per cent aqueous phenol[10] was found to be 11 3 per cent (average of values for eight fibres, coefficient of variation 24 2 per cent, probable error 1 0) for fibres that had been pretreated for two days with 0 1 *M* iodoacetamide at *p*H 8 , as compared with 25 5 per cent (seven fibres, coefficient of variation 11 3 per cent, probable error 1 2) for untreated fibres from the same staple.

I am indebted to Dr P C Carman for his advice and criticism, to the South African Wool Board for sponsoring this work, and to the South African Council for Scientific and Industrial Research for permission to publish this report

R. W. Burley

National Chemical Research Laboratory,
South African Council for
Scientific and Industrial Research,
Pretoria
Nov 2

---

[1] Speakman, *J Text Inst*, **18**, *T*431 (1927) Astbury and Woods, *Phil Trans Roy Soc*, A, **232**, 333 (1934) Bull and Gutman, *J Amer Chem Soc*, **66**, 1253 (1944)

[2] Speakman, *J Text Inst*, **27**, *P*231 (1936) Jagger and Speakman, *J Text Inst*, **42**, *P*771 (1951)

[3] Ripa and Speakman, *Text Res J*, **21**, 215 (1951)

[4] *Science*, **119**, 70 (1954)

[5] Burley, *Nature*, [**174**, 1019 (1954)].

[6] Sanger, *Nature*, **171**, 1025 (1953) Ryle and Sanger, *Biochem J*, **58**, v (1954)

[7] Halwer, *J Amer Chem Soc*, **76**, 183 (1954)

[8] Hospelhorn, Cross and Jensen, *J Amer Chem Soc*, **76**, 2827 (1954)

[9] Burley and Speakman, *Text Res J*, **23**, 702 (1953)

[10] Zahn, *Kolloid-Z*, **113**, 157 (1949).

Molecular-sieving Properties of Starch

Molecular-sieving by porous adsorbents and carriers generally used in column chromatography is a potential analytical method[1] Comparatively little, however, is known about their working-ranges in molecular-weight separation, that is, the pore diameters of the different substances In connexion with zone-electrophoretic examination of cheese extracts on a starch column, a very distinct molecular-sieve effect was incidentally observed. In order to investigate to what extent this effect could be used for determining the molecular-weight distribution among the peptides of the sample, a solution of the cheese in citrate buffer *p*H 6 7 (21 gm citric acid monohydrate + 290 c c *N* sodium hydroxide to a volume of 1 litre) and a mixture of amino-acids dissolved in the same buffer were 'chromatographed'. The dimensions of the starch column were 2 cm × 120 cm 275 fractions of 1 ml were collected from about 75 mgm of applied substance at a rate of 4 ml /hr The elution curves obtained showed that the substance was separated into two peaks, one of which had the same position as the amino-acid peak (Fig 1), whether it was obtained from the synthetic mixture or prepared from the cheese[2]. Chromatographic and electrophoretic examination of certain fractions of these peaks confirmed the identity between the latter and the amino-acids

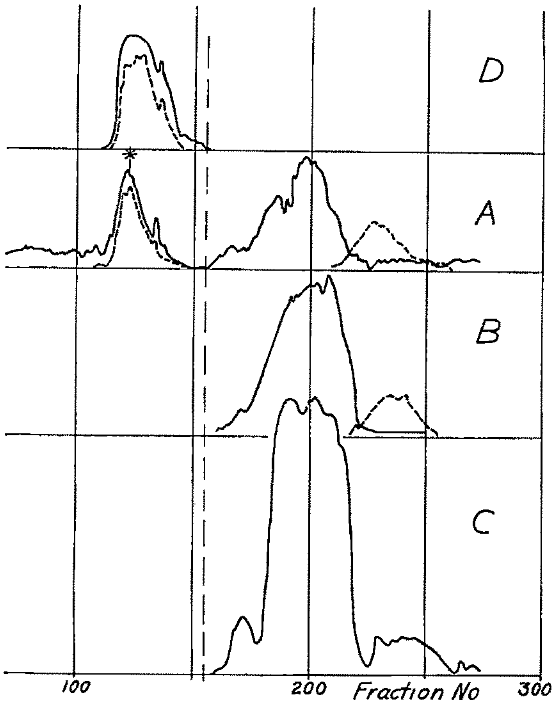


Fig 1 Molecular-sieving on starch column of cheese extracts dissolved in citrate buffer *p*H 6 7 Solid lines represent ninhydrin reaction, broken lines phosphorus content Peaks to the left of the vertical broken line (fraction 155) represent material which cannot enter the starch grains Peaks to the right of the line represent material which can freely enter the water present in the starch grains
A, Total cheese extract The asterisk * shows the fraction containing the peptide of relatively low molecular weight (see text) *B*, Amino-acids of the same extract obtained by ethanol precipitation of peptides *C*, Mixture of amino-acids in the same proportions as those in which they are to be found in casein *D*, High-molecular peptides obtained from cheese extract by dialysis

Further experiments with cheese extract dialysed in 'Cellophane' for 36 hr against tap water showed that the first peak corresponded approximately to the material which did not diffuse (molecular weight greater than 13,000[3]) In the first peak, however, there could be shown chromatographically, at the point marked * in curve *A*. a peptide forming a distinct round spot on the chromatogram This indicates that the molecular weight of this peptide cannot be very high[4]. From this we conclude that starch acts as a molecular sieve with a separation range between the molecular weights of the amino-acids (75–200) and those of the peptides which can still be chromatographed (maximum about 500) There are obviously possibilities for analytical work in this field, and it also seems that it may be possible to isolate amino-acids preparatively from mixtures of peptides using a starch column

BORJE LINDQVIST
TORSTEN STORGÅRDS

Central Laboratory,
Mjolkcentralen,
Stockholm
Nov. 11

Ion-Exchange Separations on Chemically Modified Cellulose

IN a study of methods for flame-proofing cotto fabrics, Dr J D Guthrie *et al* , of the U S Depart ment of Agriculture, have prepared a number o chemically modified cellulose fabrics and hav described[1] their ion-exchange properties The sam workers have modified the *p*H of sample solution obtained during the preparation of protein from o seed[2] by addition of phosphorylated and aminate cotton fabrics While suitable for this type o operation, the modified cellulose in fabric form is no a convenient material on which to carry out chromato graphic separations, and the possibility of convertin the fabric to pulp and then to paper has been ex plored Using aminated and phosphorylated cotto fabrics as starting materials, experimental sheets o paper have been prepared by W and R Balston Ltd , which have since been examined at the Chemica Research Laboratory The preparation of sheets o paper with suitable chromatographic properties still in the experimental stage, but the separatio of a number of inorganic mixtures has been achieve with the materials so far available

Separations of cationic mixtures were carried ou on strips of phosphorylated paper prepared fro cotton fabric which had been treated with ure phosphate This material had a phosphorus conten of 3 85 per cent and a capacity of 2 04 milliequiv per gm , which is in approximate agreement with th findings of other workers[3] that the phosphate grou is singly bound to the cellulose, leaving two hydroge atoms available for exchange Separations wer carried out on strips of paper 1 cm in width and 20 cm long A solution of mixed metal salts in dilute aci was placed near one end of a paper strip which wa allowed to dry in the atmosphere The strength o the test solution was adjusted so that the quantit of metals placed on the paper did not exceed th capacity of the area of paper covered by the drie sample spot Chromatographic development wa achieved by the upward diffusion of various aqueou salt and mineral acid solutions The position of th separated metals was then found by spraying th strip with suitable reagents

An excellent separation of iron, copper and nick was obtained using 2 *N* sodium chloride as th developing solvent When a solution containin 50 μgm of each metal was placed on the strip, ver sharp narrow bands of each metal were obtaine (Fig 1*a*) having the following R_F values . ferric iro 0 0 , copper, 0 3 , and nickel, 0 5 With the sam developing solution, aluminium and beryllium re mained with the iron, while cobalt and lead had *R* values of 0 4 and 0 5 respectively In further exper ments the quantity of metals placed on the pape strip was increased sufficiently to be in excess of th ion-exchange capacity of the area of paper covere by the test spot This resulted in wider bands, bu it was still possible to separate 0 5 mgm quantitie each of iron, copper and nickel on strips of 20 cm length (Fig 1*b*)

The separation of anionic mixtures was attempte on sheets of paper prepared from cotton fabrics whic had been treated with 2-amino-ethyl sulphuric aci Modified cellulose of this type was found to hav strong water-repellent properties, and more difficult was experienced in preparing paper suitable fo chromatographic purposes than was the case wit phosphorylated cellulose In spite of the very poo

---

[1] Synge, R L M , "Les Protéines", Rapports et discussions de neuvième Conseil de Chimie, 163 (Bruxelles, 1953)

[2] Kosikowsky, F V , *J Dairy Science*, 34, 228 (1951) Lindqvist, B , Storgårds, T , and Goransson, M -B , Thirteenth Inter Dairy Congress, The Hague, 1953, 3, 1254

[3] Umbreit, W W , Burris, R H , and Stauffer, J F , "Manometric Techniques and Tissue Metabolism", 213 (Burgess, Minneapolis, 1949)

[4] Heyns, K , and Walter, W , *Naturw* , 39, 64 (1952)

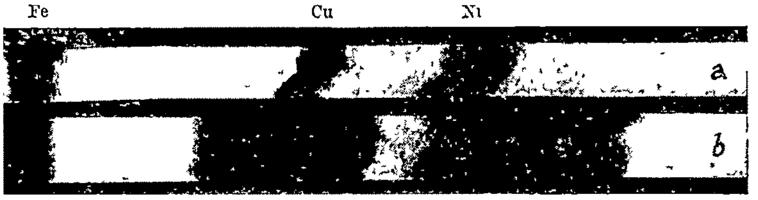


Fig 1

id uneven wetting properties of the sheets of paper ailable, it was possible to obtain a partial separation gold, platinum, palladium and rhodium as their doro acids A solution of $2N$ hydrochloric acid as used as developing solvent, and R_F values of 2 for gold, 0 3 for platinum, 0 4 for palladium and 6 for rhodium were obtained , but the bands were ffuse and slightly overlapping. Further work is in ogress aiming at producing more suitable sheets paper.

Separation of cation mixtures was also achieved columns of phosphorylated paper pulp In these periments, columns (6 cm × 1 cm) were prepared om a mixture of phosphorylated pulp blended with itreated cellulose pulp These were washed with lute hydrochloric acid to convert the pulp to the drogen form and then with a mixture of $2N$ sodium doride and $N/10$ sodium carbonate to convert to e sodium form A mixture containing 5 mgm ch of ferric iron, copper and nickel was lsorbed on to the top of each column, which was en eluted with an aqueous salt or acid solutions ith $N/2$ hydrochloric acid, copper and nickel were uted rapidly with 25 ml of acid, leaving the iron the top of the column Using molar calcium doride, nickel was eluted in the first 25 ml of solution, followed by copper in the next 50 ml of solution, hile iron was found firmly retained at the top of e column. To remove the iron it was found necesry to use a complexing agent such as acetone conining hydrochloric acid, which rapidly eluted the on and left the column in the hydrogen form ready r re-use

We thank the Director of the Chemical Research iboratory, Teddington, for permission to publish is communication

N. F Kember
R A Wells

iemical Research Laboratory,
Teddington, Middlesex
Nov. 22

Ioffpaur, C L , and Guthrie, J D , *Text Res J* 20, 617 (1950)
Ioffpaur, C L , and Guthrie, J D , *J Biol Chem* , 178, 207 (1949)
eid, J D , Mazzeno, jun , L W , and Buras, jun , E M , *Indust Eng Chem* , 41, 2831 (1949)

A Chromatographic Separation of *Meta*- and *Para*-Cresols

The separation of isomers has always been a major oblem in analytical chemistry. In the case of *meta*- id *para*-cresols, this difficulty is a very real one, for the absence of spectroscopic apparatus there is no ailable method for determining both these comonents

In this laboratory the application of partition iromatography for this purpose has been investiited, and the work has led to the complete separaon of the two isomers

In the method developed, the column is 1 cm in ternal diameter and has a packed length of 45 cm The packing is 13 gm of 'Celite 535' to which 5 ml. of the stationary phase has been added, the latter being a 0 5 M phosphate buffer of *p*H 11 5 Commercial *cyclo*hexane is the mobile phase, which is forced through the column by pressure from a nitrogen cylinder at 0 8 ml per min.

The cresols are placed on the column in a solution which is $M/100$ with respect to each component The progress of the chromatogram is followed by a spot test which is given by 2 chloro 4 nitrobenzene diazonium naphthalene 2 sulphonate A drop of the eluate is mixed with a drop of an aqueous solution of the reagent , to this is added a drop of 2 per cent sodium hydroxide, and, if any cresol is present, a red colour develops. This spot test will readily detect 5 parts per million of cresols

The eluate is collected in 2-ml fractions and analysed colorimetrically using the reagent mentioned above The results of this work are shown in Table 1. *Ortho*-cresol is included to show that all the isomers are separated, although the separation of *ortho*-cresol from the other two isomers is not particularly difficult

Table 1

	Position of peak	Total fraction containing the isomer	Weight of isomer taken (mgm)
Ortho cresol	36 5	35–40	0 1
Para cresol	59 0	56–69	0 3
Meta-cresol	77 0	72–87	0 1

The platage of the column has been calculated using the second method of James and Martin[1]. The volume which would have contained the two midstandard deviations is obtained by plotting the cumulative fraction percentages on logarithmic probability paper. This gave a theoretical plate-height of 0 45 mm.

The work has been only of a qualitative nature so far , but it is hoped to use this separation as the basis for a quantitative method of estimation of the three isomeric cresols

D White
D W Grant

Coal Tar Research Association,
Oxford Road,
Gomersal, Nr Leeds.
Nov. 23.

[1] James and Martin, *Biochem J* , 50, 679 (1952)

Potassium Permanganate in the Kjeldahl Method for the Determination of Nitrogen in Organic Substances

An investigation into the mode of occurrence of nitrogen in coals necessitated devising a suitable method for its determination The ordinary macro-Kjeldahl method was much improved in speed and reliability by using a mixed selenium–mercury catalyst with the usual potassium sulphate , but even in this case some doubt always existed as to when the conversion of all the combined nitrogen of the substances into ammonia was complete, and whether there might be loss of ammonia during the digestion, which was indeed observed when the temperature was greater than 370° C.

Quite recently, a rapid and reliable semi-micro method that uses an oxidizing agent—potassium permanganate—instead of the usual catalysts (oxygen carriers) has been described by me[1], and still more recently this has been applied to the micro-scale In the semi-micro method 1–2 mgm , and in the micro-method 0 2–1 mgm., of nitrogen are determined, digestion being conducted with 10 ml and 2 ml of sulphuric acid respectively, in 8 in × 1 in glass boiling-tubes each heated by a controllable micro-burner A preliminary digestion of about five minutes is given, and after slight cooling, potassium permanganate is added in successive small amounts with shaking until the digest becomes char-free After boiling for one minute and cooling somewhat, sufficient permanganate is added to produce a dirty sage-green coloration Digestion for a further minute completes the conversion The ammonia is determined by steam distillation from the alkalinated digest, the condenser tube being of clear silica instead of glass to avoid the pick-up of alkali, and the receiver contains 1–2 ml of a three-quarters saturated solution of boric acid Distillation is complete in six minutes, and the condensate is titrated with centinormal hydrochloric acid using methyl red–methylene blue indicator

Digestion occupies about twelve minutes, cooling about five, and the distillation and allied operations take about ten minutes, so that an individual determination can be performed in about 30 min , though it is easily possible unaided to do about thirty-six determinations per working day

Using permanganate, an investigation has shown that about 90 per cent of the nitrogen of coals has been converted at the char-free stage, the remaining 10 per cent being converted by the final permanganate addition and the short after-boiling With resistant non-charring substances, all the conversion occurs during the last period It has been found, contrary to expectation using such a powerful oxidant as potassium permanganate, that no loss of nitrogen (or ammonia) occurs at any stage of the digestion, not even when, subsequent to completion, the acid digest is boiled for two hours with excess permanganate The temperature, however, should not rise above 330°.

On the semi-micro scale coals, cereals, feeding stuffs, leather and various alkaloids of low nitrogen content have been satisfactorily tested, while the same success, using micro-amounts, has been achieved with pyridine carboxylic acids, tryptophan, and all the alkaloids so far examined

Both methods have been favourably reported upon by independent workers and can, it is believed, fairly be claimed as the most nearly perfect Kjeldahl method so far devised A considerable degree of uncertainty has existed in values obtained by earlier methods where the rate of heating, type and amount of catalyst, temperature and duration of digestion may all have adverse effects on the values obtained

The micro-method, with details of the investigations leading to its evolution, will shortly be published

A E Beet

Department of Fuel Technology,
University of Sheffield
Jan 8.

---

[1] *J App Chem* , 5, 373 (1954)

Solubility of Silica

In 1932, Kettle published experimental result which suggested that the fibrogenic activity of silic in silicosis is due to silicic acid formed when th inhaled dust dissolves in tissue fluids Since tha time, the dissolution of silica and mineral silicate in water and physiological fluids has been widel studied in laboratories concerned with pneumoconiosi research

When powdered silica is added to water, the con centration of dissolved silicic acid increases rapidl at first but afterwards much more slowly "All size of quartz particles behaved as if a soluble fractio of silica was being leached from their surfaces, leavin a relatively insoluble residue, or core, which seem to be resistant to the dissolving action of wate The amount of leachable silica which can be dissolve from the particles is greater with the samples c small size quartz than with those of larger size"

The phase of rapid solution has been variousl attributed to trace impurities in the silica[2], to rapi solution from sharp edges and corners[3] and to thick disorganized layer[4] analogous to the Beilb layer on metals The layer was estimated to b 200–1500 A thick Heavens[5] was unable to fin evidence for a thick amorphous layer on a quart crystal by electron diffraction methods

We have evidence that the anomalous solubilit characteristics of silica are due to an incomplet monolayer of adsorbed silicic acid on the silica surfac The evidence for this layer is as follows

(1) When silica is extracted with alkali, the curv corresponding to the slow reaction shows a linea concentration–time relationship Extrapolation c the curve until it cuts the axis at zero time indicate the amount of silica which dissolves rapidly As monolayer, this amount (0 13 mgm /gm on a powde of surface area 1 m ^{2}/gm) would extend over 0 16 c the surface

(2) Powder which has been treated in this way wit alkali will rapidly adsorb from a silicic acid solutio an amount of silicic acid equivalent to that rapidl removed by alkali

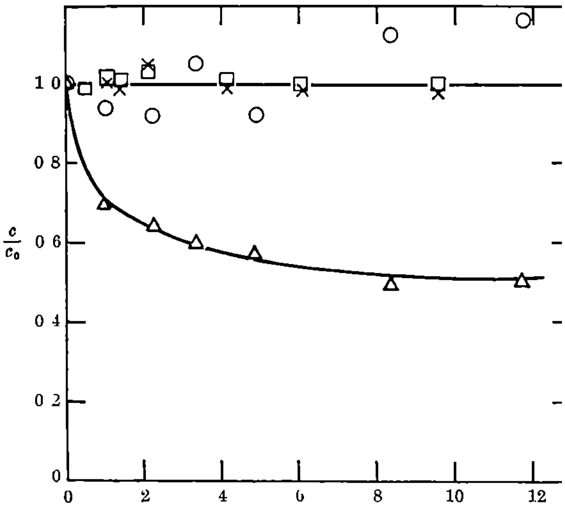


Fig 1 Alteration in the concentration of ^{31}Si-silicic acid at pH 5 (△) and pH 9 (□) and total silicic acid at pH 5 (○) and pH 9 (×) on adding a silica powder to a silicic acid solution The change in the concentration of the solute is denoted as the ratio of the concentration (c) after a measured time to the initial concentration (c_0)

(3) Silica in the layer, but not silica in the lattice, ill exchange in alkaline but not in acid solutions ith silicate solution labelled with silicon-31 When silica powder is added to a 'saturated' ^{31}Si–silicic cid solution at *p*H 5, neither the total concentration f the silicic acid nor the concentration of the labelled licic acid in the solution is changed (see Fig 1) f the experiment is carried out at *p*H 9, the total oncentration of the silicic acid is still unaltered, but e concentration of the labelled silicic acid is reduced, dicating that exchange has occurred between the issolved silicic acid and the silicic acid that is dsorbed on the silica surface

If it is assumed that the extent of the surface-yer of adsorbed silicic acid does not vary, the eight of adsorbed silicic acid in a unit weight of owder can be calculated when the surface area is nown On considering the data from several labratories, we find that the amount of silicic acid we redict to be on the surface is in most cases identical ith that which was observed to dissolve rapidly ccording to the published figures

It is evident that the widely varying 'solubility' alues previously reported for quartz represent ainly the mass of the adsorbed layer The reported ependence of the solubility on the mass of solid xtracted and on the particle size can now be xplained

A detailed account of this work will appear in the *ournal of the Chemical Society* We are indebted to he British Steel Castings Research Association for nancial assistance

P. F Holt
D T King

The University,
Reading

King, *Occup Med*, 4, 26 (1947)
Lucas and Dolan, *Canad Med Assoc J*, 40, 127 (1939)
Jotten and Pfefferkorn, *Arch Hyg*, 137, 79 (1953)
Kitto and Patterson, *J Indust Hyg and Toxicol*, 24, 59 (1942) Clelland and Ritchie, *J App Chem*, 2, 42 (1952) Nagelschmidt, Gordon and Griffin, *Nature*, 169, 538 (1952)
Heavens, *Acta Cryst*, 6, 571 (1953)

Rheological Properties of Coal during Carbonization

The work on viscosity changes in coal during rbonization first reported in *Nature*[1] has been xtended to include other rheological properties of oal, in particular its instantaneous and retarded lasticities

Coal was subjected to sudden application and emoval of stress during constant-temperature caronization in a modified Gieseler apparatus (as escribed in ref 1) and the strain-retardation and ress-relaxation phenomena were observed It was und that the mechanical properties of the coal can e represented by a spring-dashpot model The mplest model consistent with the observed pheomena is a Maxwell model in series with a Voigt–elvin model as shown in Fig 1, where two springs f stiffness G_1 and G_2 represent the elastic behaviour f the material, while two dashpots of resistance $_1$ and η_2 represent the flow viscosity and the internal iscosity respectively The relaxation-time (that is, e time in which an applied stress decays by a ctor $1/e$) is $\tau_1 = \eta_1/G_1$, while the retardation-time he time in which a strain reaches $1/e$ of its final alue on stress change) is $\tau_2 = \eta_2/G_2$

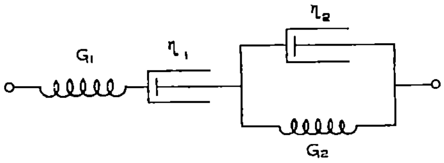


Fig 1

The modified Gieseler apparatus was used as follows The sample is raised at 3 deg C per min to a temperature within the plastic zone, and is then kept at the temperature reached A stress is applied and then removed when conditions are steady The rate of change of strain before removal gives η_1, and the strain observations after removal, which are made at 5-sec intervals for 1 min, give the values of G_1, G_2 and η_2 when extrapolated to zero and infinite time (Separate experiments showed that the extrapolation to infinite time according to an exponential law is justified) Thus, in a period of about two minutes, one set of values of the four parameters is obtained These values are assumed to remain sensibly unchanged during this short period Then change in the course of the carbonization is shown in Table 1 The values refer to a typical good South Wales coking blend (coal rank code number 301, 24 6 per cent dry ash-free volatile matter), carbonizing at 438° C The figures refer to a single carbonization, but are typical

Table 1

Parameter	Minimum value	Rises according to*
η_1	7×10^4 poises	6×10^4 exp 0 14*t*
G_1	30 to 40×10^6 dynes/cm ^{2}	40×10^6 exp 0 07 (*t*--10)†
$\tau_1 (= \eta_1/G_1)$	about 0 002 sec ‡	0 003 exp 0 07*t*
η_2	130×10^6 poises	130×10^6 exp 0 07*t*
G_2	7×10^6 dynes/cm ^{2}	7×10^6 exp 0 07 (*t*−5)†
$\tau_2 (= \eta_2/G_2)$	about 15 sec	constant at 25–30 sec

* *t* in minutes Zero time is taken at the minimum viscosity value

† The exponential rise begins later as the elasticity minima are less sharply defined than those of the viscosities

‡ The low values of τ_1 were confirmed qualitatively by direct stress relaxation measurements at constant strain

In order to test the adequacy of the model, a briquette of a Barnsley Seam coal (coal rank code number 601, 36 7 per cent dry ash-free volatile matter) was compressed during carbonization in a specially designed apparatus Allowing for the continuous contraction of the briquette (on account of loss of volatile matter) which was superimposed on the strain, the stress–strain–time relationship was found to correspond exactly to that expected from the model (see Fig 2)

By the help of the model it was possible to make allowance for the slight viscous flow in a briquette at carbonizing temperatures and to treat the briquette as a body having purely elastic properties The value of Young's modulus at these higher temperatures could then be measured (using the special apparatus mentioned above) The results show that Young's modulus increases steadily in rising-temperature carbonization, with a dip in the region of about 550°–600° C. The modulus rises to about 5×10^9 dynes/cm ^{2}, which is the highest value the apparatus will distinguish from absolute rigidity The activation energy for this process can be calculated from the temperature coefficient of the rate of rise of elasticity with time at constant temperature A value of 50 ± 8 k cal per mole was found

It is of interest to compare this latter value with that of $52 7 \pm 2 8$ k cal per mole reported earlier[1]

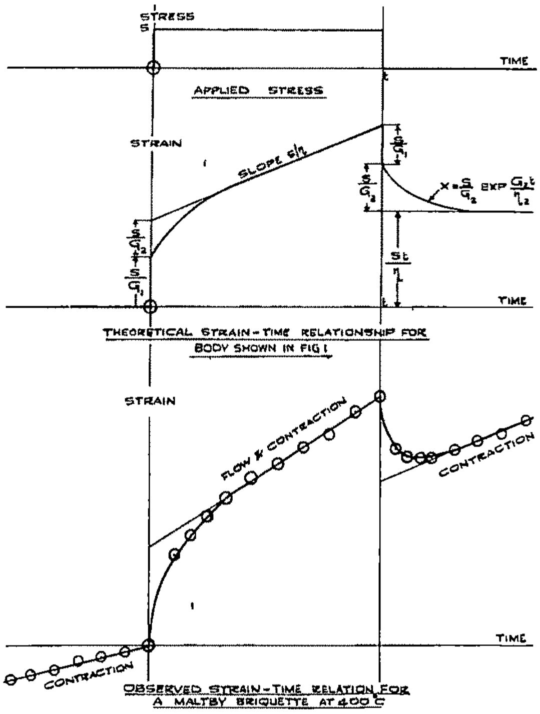


Fig. 2

for the activation energy for the decomposition reaction within the plastic zone, determined from the rate of rise of viscosity with time at constant temperature It is possible that increase both of viscosity and elasticity are aspects of the same fundamental process leading from a relatively mobile fluid to an elastic solid, and that the chemical changes taking place are of constant nature throughout

D Fitzgerald

National Coal Board,
Central Research Establishment,
Stoke Orchard,
Cheltenham, Glos
Dec 2

---

[1] Bronowski, J, *et al*, *Nature*, 171, 389 (1953) See also Ellis, Sir Charles, Inst Gas Eng, Copyright Pub, 436 (1954)

Conductivity induced in Unplasticized 'Perspex' by X-rays

The conductivity induced in unplasticized 'Perspex' (polymethylmethacrylate) by X-rays differs markedly from that induced in ordinary plasticized 'Perspex' First, the time-constant of recovery after irradiation is very long (several hours) for the unplasticized material, whereas for ordinary 'Perspex' it is much shorter[1] Secondly, the equilibrium induced current i_x is related to the dose-rate R by the general formula

$$i_x \propto R^{\Delta} \qquad (1)$$

where $\Delta = 0\ 55 \pm 0\ 05$ for unplasticized 'Perspex', but Δ is nearly unity for plasticized 'Perspex' These properties place unplasticized Perspex' in the same class of behaviour as polyethylene[1,2], polytetrafluorothene[3], and polystyrene[4,5]

The range of dose-rates was 2–64 r./min, and the range of temperature 20°–80° C for plasticized, and 20°–100° C for unplasticized 'Perspex' Th measurements were made, as previously described[1] using a d c amplifier to measure the curren in a specimen placed in a chamber which coul be evacuated The X-rays were generated a 220 kVp, with a half-value layer of 1 7 mm o copper

Dependence on temperature Fig. 1 shows the graph of log (conductivity) of unplasticized 'Perspex plotted against the reciprocal of absolute temperature The resulting straight lines are of slope proportiona to the activation energy W according to the genera formula.

$$\sigma = \sigma_0 \exp(-W/kT) \qquad (2$$

In the case of static conductivity (no inciden radiation; Fig 1*a*) $W = 1\ 6$ eV, rather greater tha for some of the other materials we have measure (polythene 1 5 eV, polytetrafluoroethylene 1 1 eV polystyrene 1 2 eV) This is consistent with the lov value of static conductivity itself observed i unplasticized 'Perspex'

For the equilibrium induced conductivity unde X-irradiation (Fig 1*b*) at $R = 7$ r/min, the slop corresponds to $W_x = 0\ 5$ eV This value of W_x i substantially the same as in the other materia mentioned, making it appear that the process o induced conductivity is fundamentally the same i all of them. The actual values of induced conductivity for unplasticized 'Perspex' are comparatively low, and similar to the values for plasticize 'Perspex'

The variations of induced current with temperatur shown in Fig 1 are consistent with the model o an exponential distribution of traps in depth, base on the theory of photoconducting insulators[6] tha we have used previously Between 20° and 80° C the induced current is observed to increase by factor of 20, whereas theory predicts a factor of when Δ = 0·55 The agreement is not unreasonabl for this type of experiment

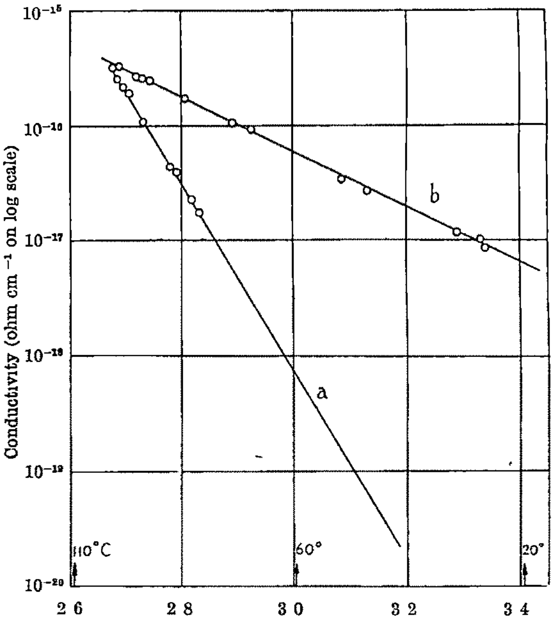


Fig 1

Table 1

Material	Δ at 80° C	Time to fall to 10 per cent at 80° C	Time to fall to 1 per cent at 80° C	Induced conductivity at 20° C for 7 r /min (ohm-cm)$^{-1}$
Polyethylene	0 8±0 05	3 min	30 min	10^{-16}
Polytetrafluoroethylene	0 62±0 05	6 hr	35 hr.	10^{-16}
Polystyrene	0 60±0 05	3 hr	20 hr	10^{-17}
Unplasticized 'Perspex'	0 55±0 05	10 hr	50 hr	10^{-17}

Table 1 lists the materials which we consider should grouped together because they display a markedly ponential distribution of traps in depth, as emplified by values of Δ which depart considerably om unity

It will be seen that the hyperbolic decay given by

$$\frac{1}{i_t} = \frac{1}{i_0} + At \qquad (3)$$

here i_t is the current remaining at time t, and A is constant characteristic of the material) is true over .e range 10–1 per cent decay for polythene but t for the other materials A full discussion of cay curve analysis will be given elsewhere, it is fficient here to say that equation (3) applies tween $t \approx 5$ min. and $t \approx 5$ hr, the decay coming exponential instead of hyperbolic at longer nes

It should be mentioned that the low conductivities easured here for unplasticized 'Perspex' will seldom obtained in practice owing to the effect of absorbed oisture.

J. F. Fowler
F. T. Farmer

Radiotherapy Department,
Royal Victoria Infirmary,
Newcastle upon Tyne
Dec. 3.

owler, J F, and Farmer, F T, *Nature*, 173, 317 (1954).
owler, J F, and Farmer, F T, *Nature*, 171, 1020 (1953)
owler, J F, and Farmer, F T, *Nature*, 174, 136 (1954)
owler, J F, and Farmer, F T, *Nature*, 174, 800 (1954)
armer, F T, *Nature*, 150, 521 (1942)
ose, A, *R C A Rev*, 12, 362 (1951)

A Semi-annual Periodicity in the Beginnings of Recurrent Magnetic Storm Series

Records of geomagnetic disturbances during the ven sunspot cycles from 1884 to 1954 reveal a ong tendency for the initial disturbance of a -day recurrent series to occur near January or ly Final disturbances of such series show this ndency only weakly.

This result was obtained from graphs of 3-day ving averages of the magnetic character figure C rough the years of declining sunspot activity, 84–91, 1895–1901, 1907–13, 1917–23, 1929–34, 38–44 and 1948–54, inclusive—a total of 48 years. l identifiable series of three or more recurrences re considered. A few series, and many individual sturbances, were of less than 'storm' intensity e method of analysis was to locate any apparent e of 27-day recurrence of magnetic disturbances, and to trace the series forward and backward in time as far as additional members could be identified. This procedure probably admitted a few random disturbances by time coincidence, but it dealt symmetrically with the initial and final members of each series.

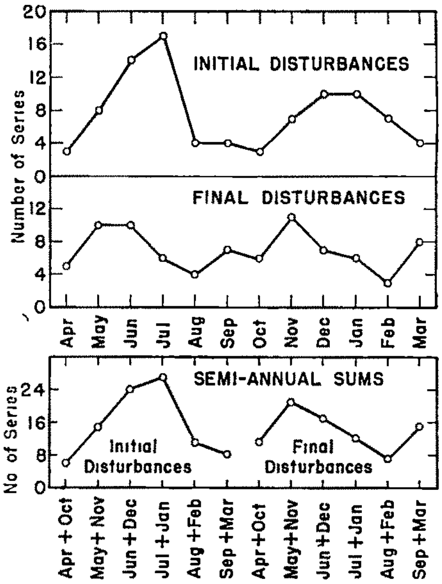


Fig. 1 Distributions of the initial and final dates of 27-day recurrent series of geomagnetic disturbances

When the dates of the initial disturbances of all the series so identified were tabulated by the calendar months in which they occurred (Fig 1), a plot of the resulting sums showed an unmistakable tendency toward a semi-annual periodicity with maxima about January and July Sixty-six of the ninety-one series began in the months May, June, July, and November, December, January, leaving only twenty-five during the other six months If the number of initial disturbances occurring in the same calendar month during a particular sunspot cycle is treated as a single datum, the probability that the observed difference between these two groups is the result of random fluctuations is about 10^{-4} The difference between the summer and winter maxima is not significant A similar analysis of the dates of the final disturbances of recurrent series suggested a weak semi-annual periodicity in phase with that of the initial dates, with the inconclusive probability 0 04.

The indication that most recurrent series begin on dates approximately midway between the equinoxes suggests a relation to the well-known maximum in recurrent storm activity near the equinoctial dates. Yet the wide range in the number of recurrences in a series (from 3 to more than 50, with a median of 18), together with the absence of a definite periodicity in the final dates of series, discourages any simple interpretation. The effect may be related to the fact that the earth crosses the plane of the solar equator on June 6 and December 7.

A tentative indication of a 23-year periodicity in recurrent storm activity, reported earlier[1], was not substantiated by this more extensive analysis

I wish to thank Dr. Walter O Roberts, director of the High Altitude Observatory of Harvard University and the University of Colorado where the research was done, Dr. Jean-Claude Pecker for suggesting

the use of the moving average plots, Mr. Fred Ward, of the Air Force Cambridge Research Center, for the use of his compilation of geomagnetic data, and Mrs. Eli Heitz, of the Observatory staff, for assistance in plotting the results The research was supported principally by the Radio Corporation of America.

J H. Rush

Department of Physics,
Texas Technological College,
Lubbock, Texas.
Nov. 1.

[1] Rush, J H, and Trotter, Dorothy E, *Astron J*, 59, 191 (1954)

Magnetic Structure of Manganese Arsenide

We have examined by neutron diffraction a number of samples of polycrystalline manganese arsenide, MnAs, prepared by Mr. A. Bentham by heating manganese and arsenic in a sealed quartz tube, with the view of confirming the antiferromagnetism postulated by Guillaud[1] in this material between the two transformation temperatures of about 40° and 130° C. No new reflexions due to antiferromagnetism have been observed, nor have we found any intensity changes within this region greater than the possible experimental errors. It seems clear that any antiferromagnetism must be very weakly developed. unfortunately, the precision of the experiment is much reduced by the fact that the important reflexions (0002) and (10$\bar{1}$1) are almost coincident in the powder diffraction pattern.

In the ferromagnetic region, from room temperature down to 80° K. which is the lowest temperature we have yet employed, the results suggest that the magnetic moments of the manganese atoms are not aligned along the c-axis, as was at first supposed, but, to a first approximation, are perpendicular to c

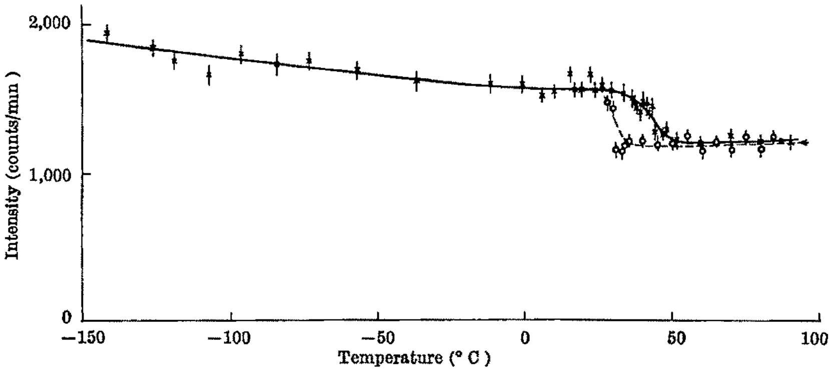


Fig 1 Neutron diffraction by manganese arsenide variation of intensity of 10$\bar{1}$0 reflexion with temperature ———, Heating, – – – –, cooling

We are at present engaged in the preparation of single crystals of the material, by fusion of manganese and arsenic in an atmosphere of argon at pressures of the order of 1,000 lb/sq in, with the hope of making a thorough investigation of the magnetic moment orientation from the much more intense and well-defined single-crystal neutron reflexions. Fig 1, which shows some results already obtained by partial isolation of a grain in a coarse-grained specimen, illustrates the power of the method. The (10$\bar{1}$0) reflexion from this grain had a peak count 1,600 neutrons per min, compared with 200 neutron per min. from a large powder sample: this coun was sufficiently large for the temperature-intensit curve to be plotted quite accurately as the substanc passed through the lower transformation temperatur due allowance being made for the change in uni cell dimensions[2] which was observed in the exper ments The temperature hysteresis in the trans formation, as indicated by the rise and fall of magnetic scattering with decrease and increase of temperature respectively, is clearly shown in Fig. 1.

It is hoped to publish a more detailed account this work at a later date

G E Bacon
Atomic Energy Research
Establishment,
Harwell, Berks.

R Street
Department of Physic
University, Sheffield

Nov 11.

[1] Guillaud, C, *J Phys*, 12, 223 (1951)

[2] Willis, B T M, and Rooksby, H. P, *Proc. Phys Soc*, B, 67, 2 (1954)

An Amplifier based on the Hall Effect

The very high electron mobility shown by the sem conducting compound indium–antimony, InSb[1], whe sufficiently pure, means that the power available fro the Hall effect is sufficiently high to make possib a number of new applications[2]. We have now bee able to achieve power amplification by using th effect in the following way.

The signal to be amplified, d.c. or a.c., is fed t a suitably matched coil wound on a laminated magnetic core, in which it induces a corresponding flu The core is closed except for a narrow gap into whic is inserted a thin rectangular slice of single-cryst indium–antimony Direct cu rent is made to flow throug the slice parallel to its lon axis, by means of soldere copper leads, the current b ing provided by a local batter The Hall effect due to th combined field and curre gives rise to an e m f. orth gonal to both. This is picke up by a pair of transverse lea and connected to a matche load. The current in the loa is then a replica of the origin signal.

In a first experimental a rangement a power gain of fi has been measured, but the is no theoretical reason wh much higher values should not be attained with single stage Cascading of stages presents no diffi culty An upper frequency-limit is set by core losse

We are indebted to the Admiralty for permissi to publish this communication

I M. Ross
N. A C Thompson

Services Electronics Research Laboratory,
Baldock, Herts.
Jan. 14.

[1] Madelung, O, and Weiss, H, *Z Naturforsch*, 9(*a*), 527 (1954)

[2] Saker, E W, and Cunnell, F A, *Research*, 7, 114 (1954)

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, March 21

Physical Society, Acoustics Group (at the Royal Institute of British Architects, 66 Portland Place, London, W 1), at 3 p m —Symposium on "Transducers"

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W C 2), at 5 30 p m —Discussion on "Materials for Valves"

Society of Chemical Industry (joint meeting of the Pesticides Group and the Agriculture Group, at the Chemical Society Burlington House, Piccadilly, London, W 1), at 5 30 p m —Meeting on "The Crop Protection Products Approval Scheme Part 3—"The Analysis of Fungicides" Mr J R Gray "Sulphur Products", Dr F R Cropper "Organo Mercurials"

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 6 p m —Prof E N da C Andrade, F R S "Creep" Second of three Cantor Lectures on "The Mechanical Properties of Metals")

Institute of Metal Finishing (at Northampton Polytechnic, St John Street, London, E C 1), at 6 15 p m —Mr R J Heritage 'Electrodeposition of Aluminium"

University of London (at the London School of Hygiene and Tropical Medicine Keppel Street, London, W C 1), at 6 15 p m —Prof W A Fowler (California Institute of Technology) "Recent Developments in American Science" * (From a series of lectures on "The United States of America")

Monday, March 21—Wednesday, March 23

Institution of Chemical Engineers (at Church House, Westminster, London, S W 1)—O E E C Conference organized by the Institution on "The Functions and Education of the Chemical Engineer n Europe"

Tuesday, March 22

Physical Society (in the Lecture Hall of the Science Museum, Exhibition Road, South Kensington, London, S W 7), at 5 p m —Prof E C Stoner, F R S "Magnetism in Retrospect and Prospect"

Imperial College of Science and Technology (at the Royal College of Science, Imperial Institute Road, London, S W 7), at 5 30 p m —Prof A R Ubbelohde, F R S "Thermodynamics in the World To day" (Inaugural Lecture)

Royal Meteorological Society (at Trinity Grammar School for Boys, Wood Green, London, N 22), at 5 30 p m —Mr F H Ludlam "Clouds" (Meeting open to Sixth-form Scholars)

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W C 2), at 6 p m —Discussion on 'High-Voltage Equipment in Colleges"

Wednesday, March 23

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 1 p m —Mr Harold F Lock "Industrial Psychology—a Practitioner's Point of View" (Chairman's Address)

Royal Society of Arts (at John Adam Street, Adelphi, London, S W 1), at 2 30 p m —Prof A C B Lovell "Radio Astronomy"

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 15 p m —Prof A Thom "A Statistical Examination of the Megalithic Sites n Britain"

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mrs Hilda Lewis "Inadequate Parents and Psychological Disorders in their Children" *

Institution of Electrical Engineers, Supply Section (at Savoy Place, London, W C 2), at 5 30 p m —Mr J Christie, Mr H Leyburn and Mr J F Bird "Proving the Performance of Circuit-Breakers, with particular reference to those of Large Breaking Capacity", Mr J Christie, Mr H Leyburn and Mr R W Fenn 'A New Testing Station for High-Power Circuit-Breakers"

Society of Chemical Industry (joint meeting of the Food Group —Nutrition Panel and the Oils and Fats Group, at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Dr S J Folley, F R S "Some Aspects of Fat Metabolism with Special Reference to the Biosynthesis of Milk Fat"

Thursday, March 24

Royal Society (at Burlington House, Piccadilly, London, W 1), at 11 a m —Discussion on "Hybrid Vigour", opened by Prof K Mather, F R S

Bone and Tooth Society (at the Institute of Orthopædics, 234 Great Portland Street, London, W 1), at 5 p m —Symposium on 'Repair Processes in Bones and Teeth"

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Prof T M Cherry "A New Quasi-automorphic Function"

Mineralogical Society (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 5 p m —Scientific Papers

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W C 2), at 5 15 p m —The Right Hon Lord Hailey "Post-war Changes in Africa"

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 5 30 p m —Mr W F B Shaw and Mr J W McHugo "Development and Use of the Calorimeter Building at the Fuel Research Station, Greenwich" *

Royal Aeronautical Society (at the Institute of Mechanical Engineers, 1 Birdcage Walk, London, S W 1), at 6 p m —Mr K V Diprose "Analogue Computing Applied to Aeronautical Problems"

Thursday, March 24—Saturday, March 26

University College London (joint meeting with the Physical Society, in the Department of Physics, Gower Street, London, W C 1) —Conference on "Recent Developments in Cloud Chamber and Associated Techniques"

Friday, March 25

Association of Clinical Biochemists, Southern Region (at the North Middlesex Hospital, Silver Street, Edmonton, London, N 18), at 3 p m —Business Meeting, followed by Scientific Papers

Royal Astronomical Society (at Burlington House, Piccadilly, London, W 1), at 4 15 p m —Discussion of papers received during the session

Physical Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S W 7), at 5 p m —Sir Geoffrey Taylor, F R S "Diffusion and Mass Transport in Tubes" (38th Guthrie Lecture)

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S W 1), at 5 30 p m —Mr R C Worster and Dr D F Denny "Hydraulic Transport of Solids"

British Association of Chemists (at the Royal Society of Medicine, 1 Wimpole Street, London, W 1), at 8 p m —Dr P Haas "Some Aspects of the Chemistry of Seaweeds"* (Hinchley Address)

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Mr George Boex "A Century of Aluminium"

Saturday, March 26

East Sussex County Council (at the County Grammar School for Girls, Lewes, Sussex), at 10 30 a m —Conference on "The Teaching of Science in Grammar Schools"

British Psychological Society, Education Section (at the Institute of Education, Malet Street, London, W C 1), at 2 30 p m —Prof Fred T Tyler (U S A) "Unity and Inter-relatedness in Human Development"

Royal Institute of Chemistry, London Section (at the University, Reading), at 2 30 p m —Symposium on "Chemical Aspects of Semiconductors"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistants (2) (preferably with an honours degree in bacteriology or equivalent qualification) in the Department of Bacteriology—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (March 26)

Lecturer in Astronomy, and Lecturers (2) in Radio-Astronomy —The Registrar, The University, Manchester 13 (March 26)

Assistant Chemist (with a degree in chemistry of a British university and/or Associate of the Royal Institute of Chemistry) for work which will involve both chemical and bacteriological analyses of water under the supervision of the chief chemist, work outside the laboratory and in the field—The Engineer and General Manager, Water Board Offices, Corporation Road, Middlesbrough (March 31)

Lecturer (with a university degree and Corporate member of the Institute of Chemical Engineers, and preferably with some previous teaching and industrial experience) in Chemical Engineering, at Birkenhead Technical College—Director of Education, Birkenhead Education Committee, 63 Hamilton Square, Birkenhead (April 2)

Scientific Officers (3) (with a first- or second-class honours degree in a scientific subject, and with an interest in administration and organization of scientific research) in the Department of Scientific and Industrial Research, London Headquarters, for scientific administration—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A 67/5A (April 2)

Assistant Lecturer or Lecturer (with special interests in infrared spectroscopy) in the Department of Chemistry—The Registrar, University College, Singleton Park, Swansea (April 6)

Reader and/or Senior Lecturer in Mechanical Engineering, Lecturer or Assistant Lecturer in Mechanical Engineering, Senior Lecturer, Lecturer or Assistant Lecturer in Civil Engineering or Surveying, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council, 1 Gordon Square, London, W C 1 (April 7)

Senior Laboratory Technician (with special training in embryology and histology) in the Department of Anatomy, University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W C 1 (April 7)

Assistant Lecturers in Applied Mathematics, Chemistry (with special reference to inorganic chemistry), Organic Chemistry, Geology (with special interests in palæontology), and Psychology —The Secretary, Birkbeck College, Malet Street, London, W C 1 (April 9)

Head of Chemistry/Physiology Group (Senior Principal Research Officer or Chief Research Officer grade) in the Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization, Canberra—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2 (April 9)

Lecturer (preferably with research experience in polymer science) in Chemistry—The Registrar, The University, Manchester 13 (April 9)

Senior Biochemist (Principal Research Officer or Senior Principal Research Officer grade) in the Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization, Canberra, to reorganize and develop a research programme in fields of relevance to basic problems of plant growth—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2 (April 9)

Lecturer or Assistant Lecturer in Mechanical Engineering—The Registrar, The University, Leeds 2 (April 11)

Chair of Chemistry at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W C 1 (April 12)

Sir Jesse Boot Chair of Organic Chemistry—The Registrar, The University, Nottingham (April 13)

I C I Research Fellows in Bacteriology, Biochemistry, Biomolecular Structure, Botany (Plant Biochemistry and Biophysics), Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying), Pharmacology, Physics, Physiology of Textile Industries (Protein Chemistry and Wool Textile Engineering)—The Registrar, The University, Leeds 2 (April 15)

Chair of Electrical Engineering—The Registrar, The University, Edgbaston, Birmingham 15 (April 16)

Physicist or Mechanical Engineer (with a good honours degree in physics or mechanical engineering, or equivalent professional qualifications, and some experience in research and practice in the instrument field) at the Central Research Establishment, National Coal Board, Isleworth, Middlesex,- to carry out research concerned with the design and development of mechanical and electromechanical instruments required for mining research, including certain aspects of health and safety—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/944 (April 20)

Shell Research Student in Chemical Engineering—Shell Professor of Chemical Engineering, Department of Chemical Engineering, Tennis Court Road, Cambridge (April 23)

Lecturer (with experience in electron microscopy) in Biophysics—The Registrar, The University, Manchester 13 (April 25)

Assistant Lecturer in Agricultural Botany—The Registrar, The University, Reading (April 30)

Chair of Botany, and Chair of Geology—The Joint Clerk to the University Court, The University, St Andrews (April 30)

Chair of Mechanical Engineering—The Registrar, The University, Sheffield 10 (April 30)

Chair of Physical Metallurgy—The Registrar, University College, Singleton Park, Swansea (April 30)

Chair of Veterinary Pathology—The Registrar, The University, Liverpool (April 30)

Senior Lecturer in Physiology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Australia, April 30)

Chair of Anthropology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (May 1)

Librarian (with a university degree in science and the qualifying certificate of the Library Association of Australia, or its equivalent, and with experience in a technical library), to take charge of a technical library serving the Division of Entomology, Division of Plant Industry and the Land Research and Regional Survey Section of the C S I R O, Canberra—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting 121/122 (May 7)

Esso Student in Chemical Engineering—The Registrar, Imperial College of Science and Technology, London, S W 7 (May 13)

Esso Students (2) in Chemical Engineering—The Registrar, University College, Gower Street, London, W C 1 (May 14)

Lecturer in the Philosophy of Science—Secretary of Faculties, University Registry, Oxford (June 1)

Esso Students (2) in Chemical Engineering—The Registrar, The University, Edgbaston, Birmingham 15 (June 11)

Senior Lecturer (with a higher degree (for example, Ph D) or equivalent qualification, and preferably with lecturing experience) in Physics, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (June 15)

Chemist or Chemical Engineer (with an honours degree in chemistry or chemical engineering or equivalent qualifications) in the Operation Branch of the Industrial Group, U K Atomic Energy Authority, Risley, to be responsible for defining the technical requirements of the raw materials uranium and thorium, and for ensuring the suitability of ores and concentrates for use in the existing and proposed extraction processes within the Industrial Group—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, Warrington, quoting 842

Chemist (with a first- or good second-class honours degree or equivalent qualification and considerable experience in general analytical work and in the rapid investigation of day-to-day problems) in the Central Laboratory, Chiswick—The Staff Officer (F/EV 528), London Transport, 55 Broadway, London, S W 1

Laboratory Technician (preferably with experience in instrument making) to develop a laboratory workshop and to assist in routine research and class preparation—The Secretary, University of Nottingham School of Agriculture, Sutton Bonington, Loughborough

Lecturer in Physics—Clerk to the Governing Body, Northern Polytechnic, Holloway, London, N 7

Physicist or Physical Metallurgist, Principal Scientific Office grade (with a first- or second-class honours degree in physics o metallurgy, and some years appropriate research experience), to lead a section carrying out basic and applied research into radioactive metals and alloys—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 542/WGE/2

Physicist (with a good honours degree in physics or physical chemistry) in the Divisional Laboratory, Birmingham, for work which includes airborne dust measurement, microscopy settlement of fine solids in water and calibration of instruments—The Divisional Establishment Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs

Physicists, Grades 1 and 2 (with an honours degree in physics or equivalent) in the Research and Development Branch, U K Atomic Energy Authority, Risley, for liaison with the research and development laboratories and investigation of research requirements in the general fields of physics, reactor technology and physical metallurgy—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P O Box 19, Risley, Warrington, quoting 837

Physicists or Physical Chemists (with a good honours degree and preferably some research experience), for work which will involve both fundamental and applied research on textile fibres and related materials—The Appointments Officer, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester

Research Assistants (2) in Physical Chemistry—The Clerk to the Governors, South-West Essex Technical College and Schoo of Art, Forest Road, Walthamstow, London, E 17

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Privy Council Medical Research Council Special Report Series No 285 Fibrosis of the Liver in West African Children. By J H Walters and J C Waterlow Pp 71+43 plates (London H M Stationery Office, 1954) 8*s* 6*d* net [311

National Institute of Agricultural Botany Farmers' Leaflet No 3 Varieties of Potatoes Pp 6 Farmers' Leaflet No 5 (Revised Jul 1954) Strains of Sugar Beet Pp 4 Farmers' Leaflet No 6 (November, 1954) Strains of Fodder Beet and Mangel Pp 6 (Cambridge National Institute of Agricultural Botany, 1954) [311

Linen Industry Research Association Report of the Council, 1954 Pp 20 (Belfast Linen Industry Research Association, 1954) [311

Association of Universities of the British Commonwealth Unite Kingdom Postgraduate Awards (Fellowships, Scholarships, Grants etc), 1954–55 List of Awards tenable at Universities in the Unite Kingdom, Short List of Awards tenable Overseas Pp 117 (London Association of Universities of the British Commonwealth, 1954) [311

Ministry of Fuel and Power Reports of H M Inspectors of Mine under the Coal Mines Act, 1911, for the year 1953 North Easter Division By C W Scott Pp ii+30 2*s* net West Midland an Southern Division By J E Henshaw Pp ii+24 1*s* 6*d* net Northern Division By W Brown Pp ii+30 1*s* 6*d* net (London H M Stationery Office, 1954) [311

Commonwealth Institute of Entomology Report of the Sixt Commonwealth Entomological Conference, 7th–16th July, 1954 Pp iv+344 (London Commonwealth Institute of Entomology 1954) 30*s* [311

Other Countries

Bulletin of the American Museum of Natural History Vol 10 Article 2 Desmatochoerinae a New Subfamily of Oreodonts B Prof C Bertrand Schultz and Charles H Falkenbach (Contribution t the revision of the Oreodonts (Merycoidodontidae), Nr 6 Publicatio of the Frick Laboratory, Department of Mammals , The America Museum of Natural History, in cooperation with the University o Nebraska State Museum) Pp 143–256 Vol 105, Article 3 Lowe Leonardian Brachiopoda of the Sierra Diablo By Francis Greenoug Stehli Pp 257–358+plates 17–27 1 75 dollars Title Page and Inde to Vol 103, 1953–54 Pp viii+465–469 Title Page and Index t Vol 104, 1954 Pp viii+461–469 (New York American Museu of Natural History, 1954) [211

Unesco Middle East Science Cooperation Office List of Scientifi Papers published in the Middle East (Afghanistan, Cyprus, Egypt Iran, Iraq, Israel, Lebanon, Pakistan, Sudan, Syria and Turkey) No 8 (December 1952) Pp i+85 No 9 (December 1953) Pp i+74 No 10 (July 1954) Pp i+74 (Cairo Unesco Science Cooperation Office, 1952–1954) [211

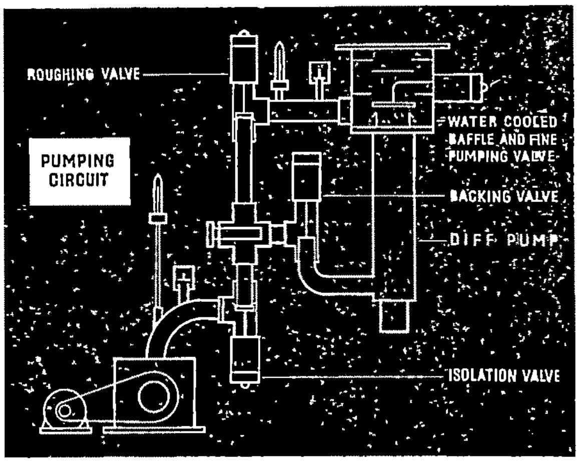
Carnegie Institution of Washington Publication 603 Contribution to Embryology—Vol 35, Nos 231–241 Pp iv+237+54 plates (Washington, D C Carnegie Institution of Washington, 1954) 1 dollars, paper , 13 dollars, cloth [231

New Zealand Forest Service Forest Research Institute Fores Research Notes, Vol 1, No 11 Annual Report of the Forest Researc Institute for the year ended 31 March 1954 Pp i+30 Vol 1, No 12 Combined Taper and Volume Tables for *Pseudostuga taxifolia* Rotorua *Pinus nigra* var *calabrica*, Rotorua , *Pinus radiata*, Rotorua By G Duff Pp i+39 (Wellington Government Printer, 1954) [311

Scientific Reports of the Indian Agricultural Research Institut for the year ended 30th June 1952 Pp i+108 (Delhi . Manager c Publications, 1954) 4 rupees, 2 annas , 6*s* 6*d* [311

Veröffentlichungen des Fraunhofer Instituts Frieburg I B Sonnen Zirkular für die Monate Juli, August, September 1954 Pp 3 (Freiburg im Breisgau Fraunhofer Institut, 1954) [311

Report of the King Institute of Preventive Medicine, Guindy, fo the period from 1st April 1951 to 31st March 1952, and Report of th Government Analyst, Madras By Dr Y S Narayana Rao and Sri Narayana Ayyar Pp 119+2 (Madras Government Pres 1954) [311



Fully automatic and
protected pumping plant
for sequence pumping

Send your enquiries to

N.G.N. ELECTRICAL LIMITED

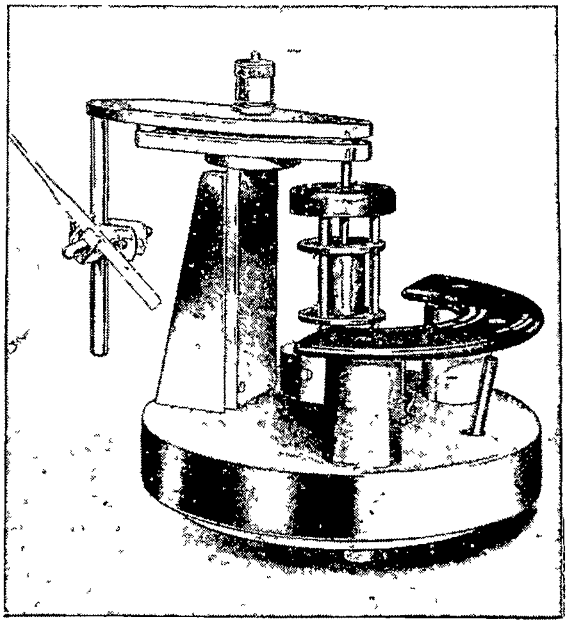
NASSAU MILL PATRICROFT MANCHESTER
TELEPHONE ECCLES 1643

DESIGNERS & MANUFACTURERS OF HIGH VACUUM EQUIPMENT

SINGER MICROMANIPULATORS

(patent application 11559/43 Foreign patents pending)

As described by Barer and Saunders-Singer, Q J M S , Vol. 89, pp 439-74, Dec 1948

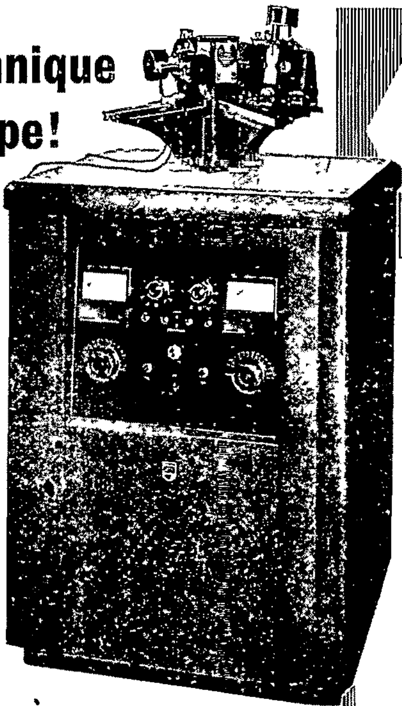


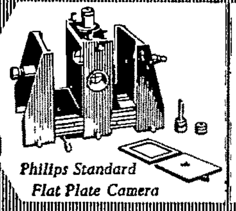
SINGER INSTRUMENT COMPANY LIMITED
Fountain Court, 83 London Street, Reading, Berks, England
Manufacturers also of the Singer Microdissectors

No known technique beyond its scope!

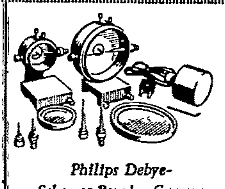
PHILIPS PW.1010

X-ray Diffraction Unit





Philips Standard Flat Plate Camera



Philips Debye-Scherrer Powder Cameras

SOME SALIENT FEATURES

- Always ready to switch on — Philips " sealed-off " X-ray diffraction tubes with four mica-beryllium windows
  High intensity, great spectral purity
- Detachable, shockproof, rayproof shield
- 4 rotatable 6-position filter discs and 4 electro-magnetically operated shutters — one for each of 4 windows
- Optimum stabilization of high tension and tube current
- Smoothed direct voltage adjustable between 10 kV and 54 kV
- Can be operated without supervision
- Goniometric recording with very accurate intensity measurements
- Weissenberg technique
- Any type of camera can be used

A product of N V Philips, Eindhoven Holland

52-page fully descriptive brochure available from :-

PHILIPS ELECTRICAL LTD
X-RAY DIVISION

CENTURY HOUSE SHAFTESBURY AVENUE LONDON WC2

(PXI 0062A)

LECTURES AND COURSES

B Sc LONDON UNIVERSITY

Courses of Study for Entrance, Intermediate Science, and the final B Sc Examination (General or Special), are provided by UNIVERSITY CORRESPONDENCE COLLEGE, founded 1887 Also for other London University Degrees and Diplomas, G C E (all Examining Bodies), Pharmaceutical Society Intermediate, etc The College, an Educational Trust, has a staff of highly qualified Tutors Prospectus from Registrar (53), Burlington, House Cambridge

UNIVERSITY OF LEEDS

POSTGRADUATE SUMMER SCHOOL, 1955
SEPTEMBER 5 to 16
POLARIZATION MICROSCOPY AND
OPTICAL CRYSTALLOGRAPHIC METHODS

The course will deal with the theory and use of the polarizing microscope in chemistry and other branches of science and technology, and will consist largely of practical work The study of opaque materials by reflected polarized light and of fibres and biological material, will be included Tuition fee 15 guineas

Details from the Secretary, Department of Adult Education and Extra-Mural Studies, The University, Leeds, 2

OFFICIAL APPOINTMENTS

***The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged* 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order* 1952**

TEES VALLEY WATER BOARD

APPOINTMENT OF ASSISTANT CHEMIST

Applications are invited for the post of Assistant Chemist at a salary of £625 to £725 per annum (Grade APT III of the National salary scales) The work will involve both chemical and bacteriological analyses of water under the supervision of the chief chemist, and work outside the laboratory and in the field Applicants must hold a degree in chemistry of a British university and/or be Associates of the Royal Institute of Chemistry Some knowledge of biology will be an advantage The successful applicant must devote his whole time to the work of the Board and will be required to pass a medical examination The appointment will be subject to the provisions of the Local Government Superannuation Acts

Applications, stating age qualifications and experience, accompanied by three recent testimonials should reach the undersigned not later than March 31, 1955

T S R WINTER, M I C E , A M I W E ,
Engineer and General Manager
Water Board Offices
Corporation Road, Middlesbrough

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Assistant Lecturer or Lecturer in the Department of Zoology The initial salary for an Assistant Lecturer will be £550 per annum The initial salary for a Lecturer will be within the range £650 to £800 per annum, according to qualifications and experience

Applications, stating age, experience and academic qualifications, together with the names of three referees, should be received not later than April 2, 1955, by the undersigned, from whom further particulars of the conditions of appointment may be obtained

STANLEY DUMBELL,
Registrar

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

Assistant Technical Secretary (male or female) required in the Metallurgy Division at the Association's London offices A general science degree or equivalent qualification is essential, but experience in metallurgical analysis, metallography or physical testing would be advantageous Duties will be mainly concerned with the organization of committees and conferences and will involve some travelling and liaison with laboratories in Sheffield Starting salary up to £775 per annum, according to age qualifications and experience Post is superannuated under the F S S U

Written applications only, quoting "Assistant Technical Secretary," to the Personnel Officer, B I S R A , 11 Park Lane, London, W 1

BRITISH CAST IRON RESEARCH ASSOCIATION

has vacancies on its Research Staff for men aged 22-35, qualified in any of the following metallurgy, physics, chemistry, engineering Experience in connection with ironfounding not essential An excellent avenue of approach is provided to a career in an enterprising industry The investigators are required for work on dephosphorization (involving considerations of ore beneficiation, blast furnace practice, top blowing, slag/metal reaction, cupola operation, etc) solidification mechanisms melting furnace operation, graphite formation, mould/metal reactions, moulding sands, the properties of cast iron at elevated temperatures and other subjects Facilities are available for fundamental and for applied work Ample opportunity for travel, for continuous contact with industry, and ultimate employment within the industry The salaries will follow those of the Scientific Civil Service, and appointments will normally be in the Scientific Officer (£445 to £815 per annum), Senior Scientific Officer (£935 to £1,090 per annum) and Principal Scientific Officer (£1,090 to £1 472 per annum) grades, but special qualifications will receive consideration The Association is situated in the country, within easy reach of Birmingham and Redditch Superannuation

Applications to the British Cast Iron Research Association, Alvechurch, Birmingham, giving age, qualifications and experience

UNIVERSITY OF QUEENSLAND

AUSTRALIA

Applications are invited for the position of Lecturer (Grade I) in Chemical Engineering Salary £A 1 275 to £A 1,450 per annum Applicants should hold a degree in chemical engineering (either an engineering or science degree in chemical engineering or an applied science degree in chemical engineering or industrial chemistry), or an equivalent degree, together with professional experience in the subject, particularly in design and related aspects The degree and experience qualifications should be sufficient for acceptance to corporate membership of the Institution of Chemical Engineers Applications close April 30 1955

Further particulars are obtainable from the Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1, or from the undersigned

C PAGE HANIFY,
Registrar

UNIVERSITY OF SYDNEY

AUSTRALIA

Applications are invited for the position of Senior Lecturer in Physiology It is particularly desired that the successful applicant engage in research in the fields of cardiovascular or respiratory physiology The salary for a Senior Lecturer is within the range of £A 1,500 to £A 1 750 per annum, with annual increments of £A 50 The salary is subject to deductions under the State Superannuation Act The commencing salary will be fixed according to the qualifications and experience of the successful applicant Finance available for home purchase under Staff Member's Housing Scheme

Further particulars and information as to the method of application may be obtained from the Secretary Association of Universities of the British Commonwealth, 5 Gordon Square London, W C 1 The closing date for the receipt of applications in London and Australia, is April 30, 1955

TEA RESEARCH INSTITUTE OF EAST AFRICA

P O BOX 91, KERICHO, KENYA
CHEMIST

Applications are invited for the appointment of Chemist Applicants should have an honours degree in chemistry (biochemistry or agricultural chemistry) of a British university, and some research experience Salary scale £700 by £75 to £1,750 A starting salary above the minimum may be offered to a candidate with suitable experience Provident fund and free furnished quarters Home leave, six months after completion of three years service

Applications by airmail, giving the names of two professional and one personal referee should be sent to arrive before April 30, 1955 to the Director, from whom detailed information on conditions and duties are obtainable

BELFAST EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY
Principal D H Alexander, O B E , M Sc
Wh Sch , M I Mech E , M I Mar E

Applications are invited for the following
tions in College of Technology, Belfast (a) Se
Lecturer in Chemistry, with special qualificat
in Inorganic and Analytical Chemistry
Teacher of Chemistry (c) Teacher of Scie
(d) Teacher of Mathematics The salary in
case will be in accordance with the scales
down by the Ministry of Education for Nort
Ireland for teachers in technical institutions
fixing the commencing point on the scale
teachers, allowance will be made for prev
teaching and industrial experience, in the l
case up to a maximum of ten years

Fuller particulars and form of application
be obtained from the Principal, College of T
nology Belfast, with whom completed applicat
must be lodged not later than Friday Apri
1955

J STUART HAWN
Director of Educat

MAKERERE COLLEGE

THE UNIVERSITY COLLEGE OF EAS
AFRICA

Applications are invited for Chair of Chemi
Salary scale £2,000 by £100 to £2,100 per ann
point of entry determined by qualifications
experience Temporary cost of living allow
at present £162 per annum F S S U C
allowance £50 per annum per child (maxim
£150 per annum) Free passages for membe
staff and family (up to four adult passages)
appointment, termination, and leave (three mo
every two years) Rent according to qua
provided, £45 to £85 per annum (including
furniture

Applications (eight copies), giving full quali
tions and experience and naming three referees
be received by April 12, by Secretary In
University Council for Higher Education Overs
1 Gordon Square, London, W C 1, from wh
further particulars may be obtained

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Lect
in the Department of Mechanical Engineer
The duties of the Lecturer will be mainly
teaching of Engineering Design and Drawing
candidates for the post should have a good de
in engineering and some industrial experie
Experience in engineering design is desirable
not essential The initial salary will be within
range £650 to £1,350 per annum, according
qualifications and experience

Applications, stating age, qualifications and
perience, together with the names of t
referees, should be received not later than A
13, 1955, by the undersigned, from whom fur
particulars of the conditions of appointment
be obtained

STANLEY DUMBEL
Regis

CITY OF CARDIFF EDUCATIO COMMITTEE

COLLEGE OF TECHNOLOGY AND
COMMERCE
Principal Dr A Harvey, B Sc , F Inst P

Applications are invited for the post of H
of the Department of Chemistry and Biol
Applicants should have appropriate academic
industrial qualifications The salary will be
accordance with Grade III of the Burnham
port, i e , £1,215 by £25 to £1,365 The succ
ful candidate will be required to take up
on September 1, 1955

Forms of application and further particu
may be obtained from the undersigned on rec
of a stamped addressed foolscap envelope
should be returned as soon as possible

ROBERT E PRESSWOO
Director of Educat
City Hall,
Cardiff

NORTHERN POLYTECHNIC

HOLLOWAY, LONDON, N 7

The Governing Body invite immediate appl
tions for appointment in September as Lect
in Physics to teach up to B Sc special de
standard Facilities are available for resea
Salary scale (men) £965 by £25 to £1,
(women) £772 by £20 to £852, plus Lon
allowance

Form of application, together with full part
lars, will be forwarded on receipt of a stam
addressed foolscap envelope

R H CURRELL, A S A A
Cl

INIVERSITY OF ABERDEEN

plications are invited for the following posts
n Department of Natural Philosophy Lec-
hip in Experimental Physics, salary scale (c)
) Two Lectureships in Electronics, one on
y scale (c) or (b), the second on salary scale
Revised salary scales (c) £1,350 to £1,550
innum, (b) £950 to £1,350 per annum, (a)
to £950 per annum Assistantships in Ex-
iental Physics, Theoretical Physics, and
ronics, on revised salary scale £550 to £650
innum Appointment as Assistant renewable
hree to five years, with possibility of appoint-
as Lecturer if vacancy occurs or if of ex-
onal merit (2) In Department of Agricul-
Lectureship in Agriculture Qualifications
red in Agricultural Engineering with special
ence to farm equipment and surveying
y on revised scale (a), £650 per annum, rising
50 per annum All posts carry F S S U and
ren's allowance, initial placing according to
fications and experience, part of removal
ises refunded
plications (eight copies for Lectureships, two
s for Assistantships), should be lodged not
than April 15, 1955, with the undersigned,
whom forms of application and conditions
ppointment should be obtained Applicants
de the British Isles may submit one copy

W S ANGUS,
Secretary

ersity of Aberdeen

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

aduate with honours degree in chemistry or
llurgy required to undertake research in the
ods of preventing corrosion of iron and steel
work will involve development of laboratory
ods of testing in parallel with the conduct
xposure tests at a number of corrosion
ons Starting salary up to £750 per annum,
ding to age, qualifications and experience
post is superannuated under the F S S U
tion London
ritten applications only, quoting "Corrosion"
he Personnel Officer, B I S R A, 11 Park
London, W 1

IVERSITY OF NOTTINGHAM

DEPARTMENT OF METALLURGY

boratory Technician required, whose main
s will be to take charge of Metallurgical
s, and to prepare samples for laboratory
es Candidates should have some knowledge
iemistry and also experience in general work-
practice Salary within the scale £340 to
according to qualifications and experience
ion scheme
ritten applications to the Registrar, Notting-
University, as soon as possible

IVERSITY OF MANCHESTER

plications are invited for the post of Lecturer
iophysics The post is newly established and
cants should have had experience in Electron
oscopy Salary on a scale £650 by £50 to
0 per annum, initial salary according to
fications and experience Membership of
U and children's allowance scheme
plications should be sent not later than
11, 1955 to the Registrar, the University,
chester 13, from whom further particulars
forms of application may be obtained

NTRAL RESEARCH ESTABLISHMENT,
onal Coal Board (at Isleworth, Middlesex),
applications for superannuable appointments
Physicists or Mechanical Engineers to lead
s being formed for the investigation of the
ical processes of coal winning A detailed
of the fundamental principles of the mech-
l breaking of coal from the seam will form
initial attack which will be expected to lead
nprovements in existing methods and the de-
oment of new techniques This work will be
ed out in the laboratory in the formative
s but underground tests will be made as re-
d to confirm the validity of the conclusions
orking conditions Candidates should have
od honours degree in physics or mechanical
ieering, considerable experience in research,
possess scientific originality and initiative
ointments will be as Scientist Grade I, scale
50 by £40 to £1,350 thence by range to £1,550
e), London location allowance of £82 mini-
rising to £100 at the maximum, is payable in
tion—Write, giving full particulars (in
nological order), of age, education, qualifica-
and experience (with dates), to National
Board, Establishments (Personnel), Hobart
se, Grosvenor Place, London, S W 1, marking
lope TT/943 Original testimonials should
be forwarded Closing date April 18, 1955

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston, Berks, requires a number of Design Engineers to lead groups of engineers engaged upon the design and development of mechanical engineering requirements Applicants should possess a degree, preferably with honours, in mechanical engineering, and have served an engineering apprenticeship, or have had considerable workshop experience They should have had a number of years' experience in mechanical design, and have been in control of complete projects, carrying them through to the final stage A high standard of technical judgment is essential and initiative, drive and adaptability are required The salary will be up to £1,500 per annum, according to qualifications and experience The successful applicants will be required to join the Authority's Principal Superannuation Scheme and contribute 6 per cent of salary Housing will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities—Application form from Senior Recruitment Officer, A W R E, Aldermaston, Berks Quote Ref WGE/555/34

CITY OF CARDIFF EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY AND COMMERCE

Principal Dr A Harvey

Applications are invited for the post of Lecturer in Mechanical Engineering For this post an honours graduate who can offer mechanical engineering design would be preferred Other subjects offered should be stated The salary payable will be in accordance wihh the current Burnham Technical Report, viz, Lecturer £965 by £25 to £1,065

Application forms, together with further particulars, may be obtained from the undersigned on receipt of a stamped, addressed foolscap envelope and should be returned by April 5, 1955

ROBERT E PRESSWOOD,
Director of Education

City Hall,
Cardiff

UNIVERSITY OF BIRMINGHAM

FACULTY OF MEDICINE

APPOINTMENT OF LECTURER IN BACTERIOLOGY

Applications are invited from science graduates of British universities for a Lectureship (Grade III) in the Department of Bacteriology at a commencing salary of £550 a year Applicants should have either a degree in bacteriology or a degree in which bacteriology was the principal subject, a preference will be given to those who hold an honours degree in bacteriology

Applications (four copies) should reach the Assistant Registrar of the Medical School, Birmingham, 15, not later than April 2, 1955 Further particulars may be obtained from the undersigned

G L BARNES,
Secretary

The University,
Birmingham, 15

HUDDERSFIELD TECHNICAL COLLEGE

Principal Dr W E Scott, M.B E

Required for September 1, 1955, a Grade "B" Assistant in Chemistry Applicants must have graduate or A R I C qualifications Burnham scale, viz (men) £585 by £25 to £880 per annum, (women) £523 by £20 to £703 per annum, plus allowances for first- or second-class honours degree and training Industrial experience will be considered in fixing the starting salary

Forms and further particulars obtainable from the Principal, Technical College, Queen Street South, Huddersfield, to whom applications should be returned as soon as possible

H GRAY,
Chief Education Officer

NEW ZEALAND DEPARTMENT OF AGRICULTURE

Applications are invited from suitably qualified persons to fill the undermentioned vacancies in New Zealand Vacancy 331, Veterinary Research Officers, Animal Research Station, Wallaceville (Ref 3/4/28) Commencing remuneration according to qualifications and experience within salary range £N Z 915 and £N Z 1,220 per annum Applicants should be graduates in Veterinary Science Duties include diagnostic work on animal diseases Vacancy 332, Technician, Animal Research Station, Wallaceville (Ref 3/4/40) Commencing remuneration within salary range £N Z 745 to £N Z 850 per annum, according to qualifications and experience Applicants should have had experience in veterinary diagnostic work, together with Associateship of the Science Technologists' Association, or equivalent Duties will include the diagnosis of poultry diseases

Application forms, together with further information and conditions of appointment, may be obtained on request from the High Commissioner for New Zealand, 415 Strand, London, W C 2, quoting reference numbers as above and mentioning this paper Completed applications in duplicate, accompanied by copies only (also in duplicate), of two recent testimonials, to be lodged not later than April 8, 1955

UNIVERSITY OF BIRMINGHAM

FACULTY OF SCIENCE

CHAIR OF ELECTRICAL ENGINEERING

The Council invites applications for the Chair of Electrical Engineering at a salary not less than £2,400 per annum It is desired that the successful applicant should take up his duties not later than October 1, 1955

Three copies of the application, together with the names of three referees, should be sent before April 16, 1955, to the Registrar, The University, Edgbaston, Birmingham, 15 Further particulars may be obtained from the undersigned

G L BARNES
Secretary

The University,
Birmingham, 15

ROYAL FREE HOSPITAL

BIOCHEMIST NON-MEDICAL IN DEPARTMENT OF CHEMICAL PATHOLOGY

Applications are invited from science graduates for the post of Biochemist, non-medical (basic grade, Whitley Scale) in the Department of Chemical Pathology Commencing salary £585, plus London weighting Previous experience of hospital biochemistry or of bio-assay methods is desirable, and there will be opportunity for original work

Applicants should send by April 1, 1955, details of qualifications and experience, with the names of two referees, to the Secretary, Royal Free Hospital, London, W C 1, from whom further particulars can be obtained

TEMPORARY POSTS FOR GEOLOGISTS

The Minister for Industry and Commerce is prepared to engage graduate geologists for temporary duties during the summer months of 1955 Geologists applying should have had two seasons' field experience in Ireland

Full details may be obtained from the Secretary, Department of Industry and Commerce, Kildare Street, Dublin

D P SHANAGHER,
Secretary

Dept of Industry and Commerce

THE UNITED KINGDOM ATOMIC Energy Authority has vacancies for Physicists Grades I and II in the Research and Development Branch at Risley for liaison with the research and development laboratories and investigation of research requirements in the general fields of physics, reactor technology and physical metallurgy A sound general education in physics, both classical and nuclear, laboratory or industrial experience and a willingness to work in a closely knit organization of engineers, scientists and mathematicians are needed The senior posts may carry responsibility for the work of a small section

Qualifications An honours degree in physics, or equivalent

Salaries Grade I £1,425 to £1,620
Grade II, £1,065 to £1 370

The successful candidates will be required to join the Authority's contributory pension scheme Applications to UNITED KINGDOM ATOMIC ENERGY AUTHORITY, Industrial Group Headquarters, P O Box 19, Risley, Warrington, quoting 837

COLLEGE OF TECHNOLOGY
BIRMINGHAM
DEPARTMENT OF METALLURGY

Applications are invited for the following post Senior Lecturer to be responsible for teaching advanced physical metallurgy to honours B Sc (metallurgy) and A I M standards and to participate in the postgraduate and research work of the Department Candidates should have at least an honours degree in metallurgy of a British university or equivalent together with substantial experience in research or industry Teaching experience is desirable and a specialized knowledge of physical metallurgy is essential Salary will be in accordance with the Burnham (Further Education) Scale for Senior Lecturers (men £1 065 by £25 to £1 215) Appointment to date from September 1, 1955

Further particulars and form of application may be obtained from the Registrar, College of Technology Suffolk Street Birmingham, 1 and completed forms should be returned to him not later than two weeks after the appearance of this advertisement

K R PILLING
Clerk to the Governing Body

WEST OF SCOTLAND AGRICULTURAL COLLEGE

The Governors invite applications for the post of Assistant Veterinary Investigation Officer Candidates must be Members of the Royal College of Veterinary Surgeons and have experience of general veterinary practice among farm animals and preferably laboratory experience Salary scale (including pay addition etc) A V I O (provincial) £648 (age 25) rising to £1,150 On entry to the scale one increment will be given for each year of age over 25 up to age 32

Forms of application and further particulars may be obtained from the undersigned, with whom applications should be lodged not later than April 9, 1955

N B BAIN,
Secretary

6 Blythswood Square,
Glasgow C 2

UNIVERSITY OF LEEDS
DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for appointment as Lecturer or Assistant Lecturer in Mechanical Engineering the salary scales are at present under review but are expected to be such as to enable an appointment to be made on the scale £650 by £50 to £1 350 a year for a Lecturer or within the range £550 to £650 for an Assistant Lecturer according to age qualifications and experience

Applications (three copies), stating date of birth qualifications and experience together with the names of three referees should reach the Registrar the University, Leeds, 2 (from whom further particulars may be obtained) not later than April 11 1955

UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for either an Assistant Lectureship or a Lectureship in the Department of Chemistry Candidates should be physical chemists with special interests in infra-red spectroscopy Salary scales Assistant Lecturer £450 by £50 to £550 per annum Lecturer £550 by £50 to £1,100 per annum Salary scales under review Commencing salary in each case will be at a point on the appropriate scale according to qualifications and experience Membership of F S S U and children s allowance scheme

Further particulars may be obtained from the Registrar University College Singleton Park Swansea to whom applications must be sent by Wednesday April 6 1955

MINISTRY OF SUPPLY NATIONAL GAS Turbine Establishment near Farnborough Hants, requires Experimental Officers and Assistant Experimental Officers for problems of combustion heat transfer aerodynamics projects and performance instrumentation and application of electronics in gas turbine research Qualifications, higher school certificate (science) or equivalent, but possession of a degree or higher national certificate in an appropriate subject may be an advantage for many of the posts A limited number of houses become available from time to time for successful candidates, if married Salary range Experimental Officer (minimum age 26) £715 to £880 Assistant Experimental Officer £288 10s (age 18) to £640 Women somewhat less—Application forms from Ministry of Labour and National Service Technical and Scientific Register (K) 26 King Street London S W 1 quoting C 146/5A Closing date April 9 1955

UNIVERSITY OF GLASGOW
LECTURESHIPS IN EXPERIMENTAL OR THEORETICAL PHYSICS

Applications are invited for Lectureships in Experimental or Theoretical Physics Salary scale Lecturer £650 by £50 to £1 350, Senior Lecturer £1 400 by £50 to £1 650 Grade of appointment and initial salary according to experience and qualifications F S S U and family allowance benefits Successful applicants will be expected to prosecute experimental or theoretical research in nuclear physics in addition to teaching duties

Applications (five copies) including the names of two referees should be lodged not later than April 30 1955 with the undersigned from whom further particulars may be obtained

ROBT T HUTCHESON
Secretary of University Court

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Lecturer in Chemistry Preference will be given to candidates with research experience in polymer science Salary on a scale £650 by £50 to £1 350 per annum, initial salary according to qualifications and experience Membership of F S S U and children's allowance scheme

Applications should be sent not later than April 9 1955, to the Registrar the University Manchester 13, from whom forms of application and further particulars may be obtained

---

THE UNITED KINGDOM ATOMIC Energy Authority, Aldermaston, Berks require a Senior Scientific Officer or Senior Experimental Officer to assist in the scientific planning of overseas trials of atomic weapons The duties involve co-ordination of the scientific effort of each participating group, and require a full scientific appreciation of all aspects of the trials This will include liaison with Service and Civil Departments Minimum qualification for the Senior Scientific Officer post is a first- or second-class honours degree in science Applicants for a Senior Experimental Officer post should be at least 35 years of age and possess higher school certificate (science), but a pass degree preferably in physics would be advantageous The salary scales are Senior Scientific Officer, £1 040 to £1 205 (male) per annum and Senior Experimental Officer £1 090 to £1 285 (male) per annum The successful applicant will be required to join the Authority's Principal Superannuation Scheme and contribute 6 per cent of salary Housing will be available within a reasonable period for married officers who live outside the radius of the Establishment s transport facilities—Application form from Senior Recruitment Officer A W R E Aldermaston, Berks Quote Ref 531/WGE/34

LONDON TRANSPORT INVITE APPLICATIONS from chemists for post in Central Laboratory, Chiswick Candidates should possess first- or good second-class honours degree or equivalent qualification The post calls for considerable experience in general analytical work and in the rapid investigation of day-to-day problems, ability to prepare reports and to draft material specifications is also necessary Salary range £875 per annum to £965 per annum, with prospects of advancement to £1 035 per annum Certain free travel facilities, medical examination contributory superannuation scheme after probation—Applications to Staff Officer (F/EV 528), London Transport 55 Broadway, S W 1 For acknowledgement enclose addressed envelope

---

ROYAL AGRICULTURAL COLLEGE Cirencester invite applications for the post of Assistant Lecturer in Agricultural Botany from honours graduates in agricultural botany, and from those expecting to graduate this summer Candidates should have special interests in plant pathology Salary in the range £500 by £25 to £750 The post will be superannuated under the Federated Superannuation System for Universities—Further particulars may be obtained from the Bursar

---

ORGANIC CHEMIST REQUIRED AT ONCE to assist in the investigation of the structure of certain hormone-like substances of plant origin Experience in the structural chemistry of natural products desirable Appointment for one year in first instance Salary £600 to £750 according to qualifications—Applications, with the names of two referees to the Secretary National Institute for Research in Dairying Shinfield, Reading, within a fortnight of the appearance of this notice Quote reference 55/5

McMASTER UNIVERSITY
DEPARTMENT OF PHYSICS
GRADUATE ASSISTANTSHIPS

Applications are invited for part-time tea
and research assistantships in the Departme
Physics McMaster University from persons
fied to register in courses leading to the
and Ph D degrees Assistantships normally
a yearly stipend of $1 450 to $1 850 Assis
are required to devote 10 to 12 hours per we
duties during the academic session (Octob
April inclusive) and are able to devote full-ti
their research during the summer Resear
in progress in the following fields Theor
Molecular Spectra F R Britton Atomic
Determinations H E Duckworth Cosmic
F Gulbis, Beta and Gamma Spectroscopy, M
Johns, Microwave Diffraction A B Mc
Solid State H E Petch Theoretical Nu
Physics M A Preston Fission Yields and
topic Abundances H G Thode

Interested persons should write to Dr H
Duckworth, Department of Physics Ham
College, McMaster University, Hamilton, Ont
Canada

ROYAL TECHNICAL COLLE
GLASGOW
(In Affiliation with the University)

Applications are invited for Two Lecture
in Mathematics In addition to classes
students of Engineering working for the
degree of Glasgow University and the C
Associateship, the Mathematics Department
vides classes of honours degree standard le
to the Associateship of the Royal Tech
College in Applied Mathematics A postgra
course in applied mathematics is to be offer
1955-56 Applicants for the Lectureship sh
have a research interest in applied mathem
preferably in fluid dynamics Salaries will b
the scale £650 by £50 to £1 350, with f
allowances and superannuation the st
salaries being dependent on qualification

Forms of application can be had from the
retary of the College

FARNBOROUGH HANTS ROYAL
craft Establishment Technical College (sele
requires Assistant Lecturer to teach Pure
Applied Mathematics and Physics up to ge
certificate of education advanced level to sylla
of new Associated Examining Board and c
dates will also be expected to assist with
subjects in national certificate and other cou
Candidates should hold a university degre
equivalent qualification and preferably have
some teaching and/or industrial experi
Salary payable in accordance with Burnham
for Assistants Grade A £450 by £18 to £725
allowances for qualifications (£90 for a
honours degree) and experience (£18 for
year's experience) The appointment is subje
the Teachers Superannuation Acts—Details
forms from Principal to whom completed f
must be returned within fourteen days of
notice

ROYAL MILITARY ACADEMY, SA
hurst Lecturers and Senior Lecturers The
Service Commissioners invite applications
men for three short service posts (a) Lectur
Modern Subjects, (b) Lecturer or Senior Lec
in Mathematics (c) Lecturer or Senior Lec
in Science For posts (b) and (c), age and
perience will be considered in making senio
pointments Candidates must have (or obta
Summer 1955) an appropriate degree (at
second-class honours) or equivalent Age at
21 years on August 1, 1955 Candidates sel
will be considered for permanent posts when
become available Inclusive Salary Scales S
Lecturer £920 to £1 195, Lecturer £462 to
Starting salary above minimum in approved c
Successful candidates expected to take up du
September 1955—Further particulars and a
cation forms from Secretary Civil Service
mission Burlington Gardens, London,
quoting No 4434/55 Application forms mu
returned by March 31, 1955

BRITISH EMPIRE CANCER CAMPA
invites applications from suitably qualified B
subjects for Exchange Fellowships in cance
search during 1955-56 Fellowships are of
year's tenure in North America at a stipen
$4 000 per annum which will be paid by
National Cancer Institute of Canada to Fel
proceeding to Canada and by the Ame
Cancer Society to Fellows proceeding to
United States Travelling expenses to and
centre of work will be borne by the Camp
The closing date for the receipt of applica
is March 31 1955—For further particulars
application forms apply to the Secretary Gen
British Empire Cancer Campaign 11 Grosv
Crescent Hyde Park Corner London S W 1

IMPERIAL COLLEGE
DEPARTMENT OF ELECTRICAL ENGINEERING

plications are invited for two Lectureships October 1, 1955 Candidates should possess od honours degree in electrical engineering preferably have completed a graduate appren- hip or have had similar industrial experience y within range £700 by £50 to £1,000 and up- ls, according to qualifications and experience, F S S U and family allowances Duties will de undergraduate and postgraduate teaching the undertaking of research

plications, stating age, academic qualifica- and experience, with the names of two ees, should reach the Head of Department, rial College, London, S W 7, by April 18,

ANIMAL HEALTH TRUST

plications are invited for the post of Director e Trust's Farm Livestock Research Station, h is being developed at Stock, Essex Veter- qualifications essential, good degree in ce desirable Salary within the range £1,750 100 to £2,250 per annum Federated Super- ation System for Universities

rther particulars from the Scientific Director, Animal Health Trust 14 Ashley Place, West- ter, London, S W 1 Latest date for receipt pplications, April 18, 1955

UNIVERSITY COLLEGE OF NORTH STAFFORDSHIRE

plications are invited for the post of Assist- Lecturer in Physics Salary in the scale £600 25 to £650 per annum, with F S S U and ren's allowances

plication forms, in duplicate, should reach Registrar, The College, Keele, Staffs, from n further particulars and application forms be obtained, not later than May 1 1955

IVERSITY OF NOTTINGHAM
LECTURER IN METALLURGY

plications are invited for the appointment Lecturer in Metallurgy Candidates should a good honours degree in metallurgy and rably also works experience Salary immedi- ppointment in the range £650 to £1,050, with ble advancement to £1,350, superannuation erated Superannuation System for Universi- and family allowance

nditions of appointment and form of applica- from the undersigned

H PICKBOURNE,
Registrar

ETALLURGIST REQUIRED TO JOIN A engaged on research into the manufacture properties of wrought metals and alloys, at Metal Working Laboratories of the British and Steel Research Association in Sheffield icants, aged 22 to 26, should have good de- be keenly interested in research and willing urther their knowledge of metallurgy and l physics as applied to the plasticity of metals mencing salary up to £750 per annum, de- ing on age and qualifications Post is super- ated under the F S S U —Written applications quoting "Metal Working," to Personnel r, B I S R A, 11 Park Lane, London, W 1

BORATORY TECHNICIAN GENERAL chemical laboratory experience essential botanical experience an advantage Salary vised scale for university technicians £340 15 bar to £480, point of entry depending on fications and experience —Apply to Professor otany, The University Edgbaston Birm ng- 15

TIONAL INSTITUTE FOR RESEARCH airying requires an Assistant Experimental r (female) as Personal Assistant to Head of ology Department Degree in biological ce or equivalent qualification, and good secre- qualifications essential Commencing salary rding to age in scale, £382½ (age 21) to £482½ 26 or over on entry) to £540 (maximum), superannuation —Applications with names wo referees, to reach Secretary of the Insti- Shinfield, Reading, within one week Quote erce 55/6

ST-DOCTORAL FELLOWSHIP AVAIL- for a physicist or physical chemist to work the physico-chemical properties of aerosols appointment will commence as soon as pos- , and in any case not later than September 55 The value of the Fellowship is £700 per m, and the appointment which will be made ne year in the first instance, will be renew- —Applications to The Clerk to the Governors, rsea Polytechnic, Battersea Park Road, lon, S W 11

UNIVERSITY OF ST ANDREWS

The University Court invites applications for the Chair of Botany in the University The Professor will be a member of the United College of St Salvator and St Leonard St Andrews The salary attached to the Chair is £2,200 per annum, plus F S S U and family allowances A grant towards expenses of removal may be made

Applications (30 copies), including the names of three referees, must be submitted by April 30, 1955, to the undersigned, from whom further particulars may be obtained

D M DEVINE,
Joint Clerk to the University Court

UNIVERSITY OF SHEFFIELD

Applications are invited for a post of Lecturer or Assistant Lecturer in Chemistry with special interest in Organic Chemistry, to begin duties on October 1, 1955 Salary scales Lecturer, £650 by £50 to £1,350, Assistant Lecturer, £550 by £50 to £650, with F S S U provision and family allowance Initial salary according to qualifications and experience

Further particulars should be obtained from the Registrar, to whom applications (three copies), should be sent by April 23, 1955

B E C C RESEARCH UNIT IN RADIOBIOLOGY
MOUNT VERNON HOSPITAL
NORTHWOOD, MIDDLESEX

Qualified Laboratory Technician required, to assist in care of animals and in biological experiments, and to prepare specimens for microscopical examination A knowledge of photography an advantage Appointment in Technician grade

Applications, with names of three referees to the Director

ROYAL FREE HOSPITAL

Technician required in early April for work in the Chemical Pathology Department and Diabetic Research Laboratory Applicants should hold the A I M L T (chemical pathology) or equivalent qualification, previous experience of clinical biochemical work would be an advantage There are facilities for original research

Applications, with full particulars to Secretary to the Board of Governors, Royal Free Hospital, Gray's Inn Road, W C 1

GRADUATES OF UNIVERSITIES OR PROfessional institutions in engineering or physics required for research in high frequency light current engineering, use of electrical equipment in inflammable atmospheres, electrical space and water heating Permanent employment qualifies for F S S U or equivalent pension scheme Starting salary £500 to £750, according to qualifications —Applications to be addressed to the Director, Electrical Research Association, 5 Wadsworth Road Greenford, Middlesex

D S I R REQUIRE THREE SCIENTIFIC Officers for scientific administration at London Headquarters Qualifications first- or second-class honours degree in a scientific subject, with interest in administration and organization of scientific research Some industrial experience and interest in personal contacts would be advantageous Inclusive annual remuneration for a 45½-hour week, £532 to £955 (men), £532 to £842 (women) Prospects of establishment if under 28 —Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting A67/5A Closing date April 2, 1955

BRITISH ELECTRICITY AUTHORITY, REsearch Laboratories Leatherhead, require Metallurgists Candidates should have a university degree or equivalent qualification in metallurgy and preference will be given to those with experience in the behaviour of metals at high temperatures Salary N J B Grade 1, £1,100 to £1 450 per annum or N J B Grade 2 £925 to £1,275 per annum, in accordance with qualifications and experience —Applications, stating age, present position and salary and giving full details of qualifications and experience to D Moffat, Director of Establishments, Winsley Street, London, W 1, by March 31, 1955 Quote Ref AE 579

THE FULMER RESEARCH INSTITUTE HAS two vacancies for supervisory staff, starting salary from £1,500 to £2,000 per annum, according to age and experience Candidates should have good degrees preferably doctorates one in metallurgy and the other in physics, with experience of carrying out and directing research Posts are permanent after one year's probation and pensionable at not less than half the maximum salaries —Apply in writing to the Director, Fulmer Research Institute, Stoke Poges, Bucks

COLLEGE OF ARTS AND SCIENCE
BAGHDAD, IRAQ

Applications are invited for a Senior Lecturer in Geology, specializing in Stratigraphy-Palaeontology, to take up duties on or before October 1, 1955 Salary scale I D 1,400 to I D 2,400 per annum, depending on qualifications, plus a cost of living allowance ranging from I D 120 to I D 168 per annum The Government contributes 10 per cent and the employee 5 per cent of his salary to the Provident Fund The Iraq Government offers a contract for one year in the first instance, renewable by mutual agreement annually Passages for applicant, wife and up to two children are paid at beginning and end of contract

Further information may be obtained from Dr A A Duri, Dean Applications should be sent by airmail to the Dean

UNIVERSITY OF TORONTO
DEPARTMENT OF PHYSICS
OPENINGS IN GEOPHYSICS

A lecturer in exploration geophysics is required in the Department of Physics, University of Toronto Salary $4,000 Acquaintance with gravimetric, electromagnetic and seismic instruments essential, field experience desirable Appointment to commence September 1, 1955

Applications are also invited for a Research Fellowship made available through funds given to the university jointly by the California Standard Company and California Research Corporation, stipend $1,800, open to students with good standing in physics and preferably with some knowledge of geology The research may be either in the field of exploration geophysics or in physics of the earth

Apply to Professor W H Watson, McLennan Laboratory, University of Toronto, Toronto 5 Canada

UNIVERSITY OF CAMBRIDGE

Applications are invited for an Assistant Curator of Invertebrates in the Museum of Zoology The person appointed will be expected to take office from October 1, 1955 An honours degree in some branch of Natural Science including Zoology is essential Museum experience, though not essential, will be considered an advantage The initial salary is expected to be of the order of £750 a year, rising by annual increments of £25 to £1,050 a year

Full particulars can be obtained from Dr A S Watt, Botany Department, Downing Street, Cambridge, to whom applications (ten copies) and the names and addresses of not more than three referees should be sent, to reach him not later than May 1 1955

H M OVERSEA CIVIL SERVICE

Permanent and pensionable vacancies at present exist for Land Surveyors in the Survey Departments of the following territories East Africa Tanganyika West Africa Federal and Northern Regions of Nigeria, Sierra Leone There are also vacancies in the Directorate of Colonial Surveys Qualifications are (i) (a) a degree (preferably with honours) in engineering, mathematics, physical science, or geography and (b) intermediate R I C S (Land Surveying Section) or exemption therefrom (ii) Professional Associateship of R I C S (Land Surveying Section) (iii) Licence to practice as a Land Surveyor in Canada, Australia, New Zealand or South Africa Final-year honours men who take their degree examination in 1955 may also apply Post-selection training up to intermediate R I C S standard would be given to such candidates

Candidates should write, giving brief details of age qualifications and experience, to the Director of Recruitment, Colonial Office Oversea Service Division Sanctuary Buildings, Great Smith Street, London, S W 1 (quoting reference BCD 428/03) for further details of terms and conditions of service

LABORATORY TECHNICIAN WITH EXperience of food and toxicological analysis, required for University of Edinburgh Department of Veterinary Hygiene and Preventive Medicine Salary scale £340 by £15 to £415 bar £440 by £20 to £480 per annum —Applications giving particulars of age, qualifications and experience, along with two recent testimonials, should be sent to the Secretary to the University Old College, South Bridge, Edinburgh, as soon as possible

ASSISTANT LECTURESHIP IN INORGANIC Chemistry now vacant, scale £600 by £50 to £700 Teaching duties mainly analytical chemistry —Applications, giving references and particulars of research and teaching experience, should be sent to Professor Barrer Chemistry Department, Imperial College, London, S W 7

NATIONAL COAL BOARD

WEST MIDLANDS DIVISION

A Physicist is required for work at the Divisional Laboratory, Birmingham, with a good honours degree in physics or physical chemistry The field of work includes airborne dust measurement, microscopy settlement of fine solids in water and calibration of instruments, and a knowledge of one or more of these is desirable

Applications to the Divisional Establishment Officer, West Midlands Division, Himley Hall, Dudley, Worcs

CHANNING SCHOOL

LONDON, N 6

Part-time Chemistry Mistress (resident or non-resident) required for the summer term to teach the subject up to 5th form standard Subsidiary mathematics or general science an advantage A graduate, qualified to teach chemistry up to university scholarship standard and to teach some mathematics or general science in addition, would be considered for permanent full-time appointment New London Burnham Scale Government superannuation

Apply immediately, with full particulars and copies of testimonials, to the Headmistress

UNIVERSITY OF ST ANDREWS

The University Court invites applications for the Chair of Geology in the University The Professor will be a member of the United College of St Salvator and St Leonard, St Andrews The salary attached to the Chair is £2,200 per annum, plus F S S U and family allowances A grant towards removal expenses may be made

Applications (30 copies), including the names of three referees, must be submitted by April 30, 1955, to the undersigned, from whom further particulars may be obtained

D M DEVINE,
Joint Clerk to the University Court

WESTMINSTER HOSPITAL

ST JOHN'S GARDENS, LONDON, S W 1

Physics Workshop Technician required from March 28 1955 Whitley Council conditions of service Salary scale £450 to £515 per annum, plus London weighting Experience of laboratory prototype work in light engineering essential

Applications, naming two referees, to House Governor within ten days

UNIVERSITY COLLEGE OF WALES

ABERYSTWYTH

Applications are invited for the post of a Trained Technician in the Botany Department, to commence duties as soon as possible Commencing salary £340 per annum

Applications, giving the names of two referees, should be sent to the Registrar immediately

APPOINTMENTS VACANT

BAKELITE LIMITED HAVE A NUMBER of vacancies for Chemists in their Research and Development Department Up to five years industrial experience (not necessarily in the plastics industry) would be an advantage There are also vacancies for chemists who will graduate or who will complete their national service in the next six months The work of the department covers a wide range of polymers and plastic materials and, in addition to original work, involves development in this country of products and processes originating in the United States Candidates for these positions should have first- or second-class honours degree or equivalent qualifications —Applications should be addressed to Research and Development Director, Bakelite Ltd, Redfern Road, Tyseley, Birmingham, 11, and should give full details of age, training, qualifications, and experience

THE BRITISH PETROLEUM COMPANY Limited has immediate vacancies for Chemists, Chemical Engineers and Mechanical Engineers for work in their United Kingdom Refineries and at their Research Station at Sunbury-on-Thames Applications are invited from men with first- or second-class honours degrees or equivalent qualifications and who have fulfilled National Service obligations Previous industrial experience desirable but not essential Age preferably not above 33 Salaries within the range £600 to £1,200, according to qualifications and experience Excellent working conditions Non-contributory pension scheme —Write, giving full details, quoting H 3297, to Box 7352, c/o 191 Gresham House, E C 2

A I M L TECHNICIANS, OR EQUIVALENT standard, required for pharmacological work Male or female —British Schering Research Institute, Alderley Edge, Cheshire

NUCLEAR REACTOR PROJECT DESIGN STUDY GROUP

A unique opportunity is offered to young men with initiative and imagination, to study nuclear power and propulsion

Applications are invited for the following posts

(1) PROJECT ENGINEER, to carry out feasibility studies on small high temperature system Background in aero-engine design would be an advantage Knowledge of heat transfer and fluid dynamics essential

(2) RESEARCH METALLURGIST, to engage in research on new materials Some knowledge of high temperature alloys, ceramics or liquid metals would be an advantage

(3) PHYSICIST to engage in experimental research on existing reactors and assist in nuclear design calculations on new types

Some knowledge of nuclear physics is desirable for (3), but is not essential for (1) and (2)

Honours degree or equivalent qualifications essential

Age 23 to 30 years

Initial salary up to £1,000 per year, depending on age and experience

Reply, giving full details of career, to Box 658, T G Scott and Son, Ltd, 143-147 Regent Street, London, W 1

ANALYTICAL CHEMIST REQUIRED TO work in Department dealing with pesticide residues on crops, atmospheric contamination and mion analysis of organic compounds B Sc or A R I C standard necessary Previous practical experience desirable Salary according to age, qualifications and experience —Write (quoting No 1025), giving fullest particulars and salary required to Personnel Manager, Fisons Pest Control Limited, Bourn, Cambridge

RESEARCH AND DEVELOPMENT ENGINEERS are required for work on Electronic Switching, Computing and Control Apparatus Applicants should preferably have had experience of one or more of the above A good university degree in engineering or physics would be an advantage Further vacancies exist for Junior Engineers and Technical Assistants Excellent opportunities for advancement to more senior positions Starting salary, according to qualifications and experience, will be in the range of £400 to £1,100 per annum The Company operates a superannuation scheme and offers attractive working conditions with generous holiday and leave arrangements, and good social and recreational facilities —All applications will be dealt with in confidence and should be addressed to the Director of Research, British Telecommunications Research Ltd, Taplow Court, Taplow, Bucks

BOTANIST OR BIOCHEMIST BETWEEN 23 and 30 years of age required by Glaxo Laboratories Ltd at their Antibiotic Factory at Ulverston, Lancs Some previous experience of industrial fermentation would be a considerable asset and preference will be given to men with a particular interest in production and management problems Salary according to qualifications and experience with good prospects of advancement —Apply to Personnel Manager, Glaxo Laboratories Ltd, Greenford, Middlesex

GEOPHYSICISTS EXPERIENCED IN OIL exploration by means of the seismograph, magnetometer or gravity meter needed for positions outside of U K Good salary Foreign bonus and living allowance —Write details of age and experience to Box N 111, c/o 191 Gresham House, E C 2

PHILIPS BALHAM WORKS LTD, 45 Nightingale Lane, S W 12, requires Graduate in Electrical Engineering or Physics preferably with experience in electronics for development of nucleonic instruments Permanent appointment with excellent prospects —Applications should be addressed to the Personnel Officer at the above address

GRADUATE, PH D OR WITH RESEAR
experience and preferably some experience
field-work, required by manufacturer of agr
tural chemicals The work will involve techi
service on existing products, formulation
evaluation of new products and supervision
field trials There will be opportunity also
development of original ideas The positio
one of responsibility and offers opportunity
prospects to a young man with chemical/agr
tural background, initiative and who wishe
further develop experience in the applicatio
chemicals to agriculture and horticulture prac
Good working facilities are available and pen
fund —Please apply with details of qualificat
and experience to Box 666, T G Scott and
Ltd, 143-147 Regent Street, London, W 1
plications will be dealt with in strictest confide

CHEMICAL ENGINEER REQUIRED
the result of a rapid expansion programm
well known pharmaceutical manufacturing
pany has a vacancy for a suitably qualified ma
Chemical Engineer The company operates se
factories in London and the Provinces and
work involves a wide variety of products
includes the manufacture and packaging of ch
cal products and pharmaceutical specialitie
various forms Applicants should possess a
versity degree or equivalent with a good k
ledge of chemical engineering and have had
perience in the operation and control of m
facturing procedures and packaging The s
will be commensurate with qualifications and
perience and will be on a generous scale —A
Box 676, T G Scott and Son, Ltd, 143
Regent Street, London, W 1

DUNLOP RUBBER COMPANY
vacancies for polymer chemists for develop
projects in the synthetic elastomers field Ex
ence or interest in emulsion polymerization w
be an advantage for two of these appointm
Applicants should preferably have an honours
gree or its equivalent and should have compl
National Service The present extension of
development activities of the company make
appointments of special interest —Application
writing, quoting reference J M 63, giving detail
age, qualifications and experience, to Perso
Manager, Dunlop Rubber Co, Ltd, Fort Dun
Erdington, Birmingham, 24

BACTERIOLOGIST VAN DEN BER
and Jurgens Ltd, Stork Margarine Works,
fleet, Essex, have a vacancy in their new lab
tories for a Bacteriologist to take charge of
section dealing with microbiology Experienc
the examination of milk and water essential
initial salary will be in the range of £600 to
per annum, according to age and qualificat
Person appointed will be entitled to member
of superannuation fund —Applications, giving
details, to be made in writing, to Perso
Manager at the above address

APPLICATIONS ARE INVITED F
Physicists with degrees or their equivalent, fo
search into machining problems associated
the manufacture of large steam and gas turb
—Apply, quoting reference TJ and stating
qualifications and experience, to the Directo
Research, The British Thomson-Houston Co
Rugby

ELECTRONIC ENGINEERS WITH
grees in physics or engineering required for
portant and interesting work on the research
development of special equipment Good o
tunity and high salary rate —Write to Man
Director, Microcell Ltd, 56 Kingsway, Lon
W C 2

PHYSICIST THE CAPE ASBESTOS C
pany require a recent graduate in physics
work in their Research Department, whic
located at the Barking Essex, Factory of
Group The work, which will be under the
tion of a senior physicist, involves researc
problems of heat transfer and the study of p
cal properties of inorganic fibrous struct
Candidates should possess a good honours de
The appointment is permanent and pensio
and offers the prospect of a career on the te
cal side of the Company —Apply Pers
Manager, Barking, Essex

A CHEMICAL ENGINEERING COMP
in the North of England requires Res
Chemists for work on physical and inor
problems Candidates should hold a
honours degree in chemistry and preferabl
below 35 years of age Salary dependent on q
fications, but will range from £650 per annu
four figures The positions are permanent a
good pension scheme is in operation Ac
modation available —Apply, giving full par
lars, to Box No 668, T G Scott and Son,
143-147 Regent Street, London, W 1

NGINEERS AND PHYSICISTS

ith a degree or higher national certificate are required for permanent posts in the

UIDED WEAPONS DIVISION

of

ENGLISH ELECTRIC COMPANY LIMITED AT LUTON

or work on analogue computors and imulators

In particular a SENIOR MAN is required o supervise the design and construction of large general purpose computor, and there re JUNIOR POSTS connected with this roject and others allied to it

Applicants should preferably have design xperience in analogue computing or related ields such as servo-mechanisms and negative eedback systems

Applications to Dept C P S, 336-7 trand W C 2, quoting Ref S A 50C

ELECTRICAL ENGINEER IS REquired by a well-known chemical concern in the North-west of England, to take harge of the electrical department at one of their large factories The department is responsible for all transforming equipment and medium voltage distribution system is installed in the factory Candidates should be between 35 to 40 years of age and have graduate or equivalent qualiations in electrical engineering At least ight to ten years' industrial experience is ssential, together with experience of management Salary will be commensurate with qualifications —Box 672, T G Scott and Son, Ltd , 143-147 Regent Street London, W 1

HE RESEARCH DEPARTMENT OF A ling industrial organization situated in the th requires two graduates to undertake the exsion of an important research project conted with the raw materials of the industry work involved, which offers ample scope for iative and imagination, will appeal to organic mists and biochemists who are interested in damental research on natural products and in lying the results of this research to the agriural and manufacturing practices of the intry Applicants must have a first- or seconds honours degree and some postgraduate exence would be useful, although not essential appointments will be to the regular staff and be pensionable with starting salaries according age and experience within the range £700 to 00 —Applications giving full particulars will treated in confidence Box No T 6208 ldon's, Salisbury Square, Fleet Street, E C 4

HE RESEARCH LABORATORY OF THE ish Thomson-Houston Co Ltd require a duate in Metallurgy or Physics to join an exding group working on the strength of metals, particular reference to high temperature proies —Apply, quoting reference HJ and stating qualifications and experience, to the Director Research, The British Thomson-Houston Co , , Rugby

---

ESEARCH ENGINEERS, PREFERABLY OF ree standard, and with a sound knowledge of munications and, particularly, electronics rered for experimental work relating to underer sound apparatus —Applications, giving past erience, technical qualifications, age and salary uired, should be addressed to the Personnel nager, Kelvin and Hughes Ltd , New North d, Barkingside, Ilford, Essex

---

TECHNICAL LIBRARIAN

Courtaulds Limited requires a male Librarian/ Information Officer in its Textile Research Laboratory, Bocking, Essex Responsibilities include the administration of a medium-sized scientific and technical library, the editing of technical reports, the preparation of literature surveys, and the indexing of current publications Applicants with a scientific degree and some knowledge of textile science and technology preferred, but a qualification in librarianship or experience in a specialist library is essential A knowledge of German is required Age 25 35 Salary in accordance with age and experience

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds Limited, 16 St Martin's-le-Grand London, E C 1, quoting the reference number D 65

PHYSICIST REQUIRED FOR *X*-RAY DIFfraction and other interesting physical investigations in a Metallurgical Research Laboratory Good prospects and scope exist Pension scheme —Apply, giving full particulars of age, qualifications and experience, to Box 669, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1, quoting reference PX

GRADUATES IN MATHEMATICS (FEMALE) required for the detailed analysis and tabulation of experimental data Previous experience not necessary —Applicants should write, giving full details to Personnel Department (E D /129), E M I Eng Dev Ltd , Hayes, Middlesex

---

A PHYSICIST IS REQUIRED TO FILL AN important post as Leader of a large Research Group on Solid State Physics He would be engaged solely on research and would work directly with the Chief Scientist, he would not be concerned with development The type of man envisaged is one having a well established reputation in the field of solid state physics and the salary offered would be commensurate with this —Application should be made to the Director Research Laboratories of the General Electric Company Ltd , Wembley, Middlesex (Ref RLH/21)

PLANT MANAGER REQUIRED FOR EXtraction Plant in East Africa Applicants should have chemical engineering knowledge and be capable of controlling European and native labour Responsible for plant installations and general maintenance Must be conscientious and undertake control of plant process Salary from £1,500 upwards according to experience Home leave, pension and bonus schemes —Write Box " MR/ 49," c/o 95 Bishopsgate, E C 2

AERODYNAMICISTS WITH A GOOD DEgree and several years' experience in aircraft or missile industry, required to work on a wide variety of dynamics problems associated with major guided weapon development Aerodynamicists with a degree or equivalent qualification, preferably with several years' experience in aircraft or missile industry required to work on analysis and development of flight trials of above weapon Competitive salaries paid for right men —Please write in detail, quoting Ref 119, to The Personnel Manager (Technical Employment), de Havilland Propellers Ltd , Hatfield, Herts

---

ANALYTICAL CHEMISTS ALBRIGHT & Wilson Ltd and Midland Silicones Ltd , have vacancies as under (1) Albright & Wilson Ltd require a qualified chemist who would act as Deputy to the Chief Chemist, for analytical duties and for research into analytical methods at their Merseyside Works The position bears responsibility and there are good prospects of advancement Age 26-30 (2) Midland Silicones Ltd require a Research Analyst in the laboratory of its factory at Barry Glamorgan for investigating and developing new methods for the analysis of organo-silicon compounds and intermediates associated with the manufacture of silicones Candidates, who should be aged 25 to 30 and possess an honours degree or A R I C should preferably have had experience of infra-red analysis These posts carry membership of a non-contributory pension scheme —Applications stating for which post intended, should be addressed to the Staff Officer, Albright & Wilson Ltd , P O Box 3, Oldbury, Birmingham

---

ORGANIC CHEMISTS REQUIRED FOR REsearch Department of Company manufacturing Technical and Fine Chemicals Honours graduates are preferred and some industrial experience is desirable although not essential The positions are permanent and pensionable and a salary up to £850, dependent on qualifications and experience, will be paid —Apply, Personnel Manager, Howards of Ilford Ltd , Ilford, Essex

---

NELSON RESEARCH LABORATORIES

ENGLISH ELECTRIC CO LTD ,

STAFFORD

have a vacancy for a PHYSICIST having an interest in solid state physics and electronics, to work on the fundamental properties and applications of materials suitable for use in electronic storage devices

An honours degree and some research experience are desirable

Salary at present-day levels in accordance with age and qualifications Please reply to Department C P S , 336-7 Strand, W C 2 quoting Ref 1353B

ATOMIC POWER DEPARTMENT

of

ENGLISH ELECTRIC

requires

MECHANICAL DESIGN ENGINEERS

This is an excellent opportunity for men with any type of medium or heavy mechanical design experience to enter this new field of engineering

Applications should be made to

Dept C P S ,
336-7 Strand, W C 2,
quoting Ref No 1318A

ATOMIC POWER DEPARTMENT

of

ENGLISH ELECTRIC

invites applications from

MATHEMATICIANS

who have or who will have in the near future, postgraduate qualifications in MATHEMATICS

Please write to

Dept C P S ,
336-7 Strand, W C 2,
quoting ref no 1367A

LABORATORY ASSISTANTS COURTAULDS Limited has vacancies for male Laboratory Assistants in its Maidenhead Research Laboratory Previous chemical laboratory experience is essential and applicants should have obtained general certificate of education in mathematics, physics/ chemistry and have completed their National Service —Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds Limited, 16 St Martin's-le-Grand, London, E C 1, quoting the reference number D 59

CHEMIST OR PHYSICAL CHEMIST REquired for interesting work in connection with research on electronic valves Previous experience is not essential, but candidates should be of at least general degree standard Age 20-30 years Salary commensurate with age and qualifications A permanent, progressive post —Write, giving full information to the Personnel Officer, Ericsson Telephones Ltd , Beeston, near Nottingham

WOOL INDUSTRIES RESEARCH ASSOCIATION

Physicists with honours degree or A Inst P required for fundamental research on (i) Adhesion, friction and abrasion of non-metallic substances (ii) Physical adsorption by polymer materials, including infra-red measurements Previous research experience not essential, opportunity for proceeding to a higher degree Commencing salary according to age and experience in range £530 to £845 per annum, with F S S U benefits

Applications to Wool Industries Research Association Torridon, Headingley, Leeds, 6

WOOL INDUSTRIES RESEARCH ASSOCIATION

Physicist with honours degree or A Inst P required for weaving research The work involves experimental and analytical investigations on looms and in the laboratory, it requires mechanical aptitude and a liking for classical physics Previous research experience not essential Commencing salary according to age and experience in range £530 to £845 per annum, F S S U benefits

Applications to Wool Industries Research Association, Torridon, Headingley, Leeds, 6

THE METAL BOX COMPANY HAS A number of vacancies in its Research Division for Scientists and Technologists experienced in the plastics industry Men are required in three grades

Grade I One vacancy Salary £1,250 to £1,500 per annum

A Graduate in Chemistry or Chemical Engineering with several years' experience in the plastics and/or synthetic resin industries, capable of planning and administering a programme of research and development work to be carried out by a team of six or seven Scientists and Technicians Previous experience should include the field of plastics extrusion

Grade II Two vacancies Salary up to £1,000 per annum

(1) Man with scientific training, not necessarily a graduate, and with experience of development work in the plastics industry, preferably in the field of extrusion

(2) A Graduate in Chemistry or Chemical Engineering with a few years' experience of synthetic resins, in the plastics rather than the coatings fields Must have knowledge of the properties and working characteristics of a wide range of synthetic resins

Grade III Two vacancies Salary up to £600 to £700 per annum

Non-graduate Laboratory Assistants with a little experience qualifying them to work under the men in Grade II above

Applications, in writing, to Ref R S /24, Staff and Personnel Dept, The Metal Box Co Ltd, The Langham, Portland Place, London W 1

APPLICATIONS ARE INVITED FROM physicists with honours degrees or their equivalent for posts in the research laboratory of the British Thomson-Houston Co, Ltd The work involves investigations of photo-conductive materials and devices but previous experience in this field is not essential—Apply, quoting reference WNB, and stating age, qualifications and experience, to the Director of Research, The British Thomson-Houston Co Ltd, Rugby

LANKRO CHEMICALS LIMITED OF Eccles, Manchester, offer an unusual opportunity with considerable scope for a highly qualified chemist of proven ability Applications are invited for the post of Senior Research Chemist A high standard in organic chemistry with keen interest in physical chemistry and at least five years' industrial experience are required Some administrative experience is desirable The company manufactures plasticisers, surface active chemicals and auxiliaries for the leather and textile industries Salary will be by negotiation and a contributory pension scheme is in operation—Applications, giving full particulars, should be addressed to The Managing Director

LADY CHEMIST, GRADUATE OR H N C required for analysis of electroplating and allied solutions—Apply, Electro-Chemical Engineering Co Ltd 161 Queens Road Weybridge Surrey

GRADUATE CHEMIST, METALLURGIST or Chemical Engineer required, to deal with problems relating to the installation of electroplating plant and process control Applicants must have completed military service and be willing to travel—Apply, Electro-Chemical Engineering Co, Ltd, 161 Queens Road Weybridge, Surrey

RESEARCH

Vacancies exist in the Research Department of SIMON-CARVES LTD for a number of alert young Research Officers The fields of interest include fluidisation, flame combustion, discharge in gases, electro-precipitation, behaviour of small particles, certain aspects of reaction kinetics and applied thermodynamics and computation of physico-chemical data Reliable Experimental Officers and Assistants are also required for work in these fields and in the analysis and testing of fuels, by-products, industrial dusts, refractories, soils, and materials of construction

RESEARCH OFFICERS

Good degree essential Initial salary in range of £600 to £900, depending on experience (Ref F P 100)

EXPERIMENTAL OFFICERS

Essential requirements either degree or H N C (or equivalent) and previous experience Non-graduates must be 26 or over to qualify Starting salary in range £500 to £650 (Ref F P 101)

EXPERIMENTAL ASSISTANTS

Good G C E or O N C required Age range 21 to 26 Initial salary between £390 and £475 (Ref F P 102)

JUNIOR EXPERIMENTAL ASSISTANTS

Candidates should have a good G C E (English, Maths and 2 science subjects) Age range 17 to 20 Salary according to age (Ref F P 103)

Working conditions are excellent, scope is good There is a pension scheme in operation Write, quoting the appropriate reference, to Staff and Training Division, Simon-Carves Ltd, Cheadle Heath, Stockport

ENGINEER, WITH ELECTRICAL OR PHYSICIST degree, required for development work on testing equipment for telecommunication cables Permanent and pensionable position at salary commensurate with experience and qualifications—Please apply, giving full particulars, to Personnel Officer Southern United Telephone Cables, Ltd Dagenham Dock, Essex

PHYSICIST OR METAL-PHYSICIST REquired for *X*-ray Laboratory (industrial radiography and crystallography) Scope for long-term research as well as technological applications Good university degree essential Candidates would be given encouragement to gain wide research experience and the seniority which this appointment is intended to carry—Applications to Personnel Dept, Hadfields Ltd, East Hecla Works, Sheffield, 9

Advertisers please note You must ad “Apply Employment Exchange” unless th employment advertised or the workers required are excepted under the Notification o Vacancies Order

THERMODYNAMICISTS WITH DEGREE equivalent qualification are required for work wide variety of problems concerned with tempe ture control and air conditioning for high spe flight A number of vacancies also exist Technical Assistants in the above field (R 125)—Please write in detail, quoting Ref of position sought to The Personnel Mana (Technical Employment), de Havilland Propell Ltd, Hatfield, Herts

THE DUNLOP RUBBER COMPANY SEE to appoint Physical Chemists for research and velopment concerning natural and synthetic lati Specialist knowledge or experience of coll chemistry or in the field of surface activity wou be an advantage but is not essential Applica should preferably have an honours degree or equivalent and should have completed Natio Service—Applications, in writing, quoting ref ence J M 64, giving details of age, qualificati and experience, to Personnel Manager Dunl Rubber Co Ltd, Fort Dunlop, Erdingt Birmingham, 24

APPOINTMENTS WANTE

BIOLOGIST EXPERIENCED TEACHE some research, and engineering experien Whole-time or vacation work—Box 674, T Scott and Son, Ltd, 143-147 Regent Stre London, W 1

GRANTS & SCHOLARSHIP

IMPERIAL COLLEGE OF SCIENC AND TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING
BURSARIES IN CONCRETE TECHNOLOG

Notice is hereby given that the election Bursaries in Concrete Technology tenable as fr October, 1955, will take place in June, 19 Candidates must hold a degree in engineering the time of taking up the award, and must a have a good knowledge of the theory of structur Bursaries are of the value of £350 per annu out of which the College Tuition Fee has to paid, the amount may be increased to £450 those with industrial experience In addition, o or two Senior Bursaries of £600 per annum m be awarded to outstanding men with a minim of three years experience in industry The cou will be postgraduate and Bursars who successfu complete the course will be eligible for the aw of the Diploma of the Imperial College (D I

Applications must be received on or before J 1, 1955, by the Deputy Registrar, City and Gu College, Exhibition Road, London, S W 7, w will, on written request, send full information a application forms

COLLEGE OF AERONAUTICS

ENGLISH ELECTRIC RESEARCH FELLOWSHIP IN AERONAUTICS

Applications are invited for a Research Fell ship which has been established at the College the English Electric Co Ltd The Fellowship intended to provide opportunity for postgradu research into problems of vibration or stabil and control of aircraft, and is tenable for o year beginning on or about October 1, 19 The value of the Fellowship is £500

Applications, giving full particulars of edu tion and experience and quoting the names three referees, are required by May 1, 1955, a should be addressed to The Warden, T College of Aeronautics, Cranfield, Bletch Bucks

SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY

GRANTS-IN-AID

The Committee will, in July, allocate a limi number of Grants-in-Aid to young men a women employed in chemical works in or n London, who desire to extend their education a career in chemical industry Applicants m not be under 17 years of age and must ha matriculation or its equivalent

Applications should be made as soon as p sible, whereupon forms will be issued requir particulars of age, nature of employment and manner in which the Grant would be used T application forms should be received, complete before May 16, 1955, by The Clerk of the Salte Company, Salters' Institute of Industrial Che istry 36 Portland Place, London, W 1

COLLEGE OF AERONAUTICS

Applications are invited for the Perring Scholarip in Aeronautics, valued £400 per annum, nable at The College of Aeronautics The sucssful candidate will be admitted to the twoar course at the College Applicants should eferably be honours graduates or final year dergraduates in engineering, mathematics or ysics, applications from non-graduates with mparable qualifications will also be considered ndidates must be British subjects domiciled in United Kingdom

Forms of application and statement of condions will be forwarded on written application to e Warden, The College of Aeronautics, Cranld Bletchley, Bucks The closing date for the cipt of applications is June 1, 1955

UNIVERSITY COLLEGE

LONDON

ESSO STUDENTSHIPS IN CHEMICAL ENGINEERING

Applications are invited from men who hold or pect to hold a good university degree in emical or other branch of engineering or in emistry for two Esso Studentships, founded by Esso Petroleum Co Ltd, tenable from Octo- 3, 1955 The value of the studentships is 50 a year, plus college fees

Applications should be submitted to the gistrar, University College, Gower Street, ndon, W C 1, by May 14, 1955, giving full rticulars of educational qualifications, industrial perience (if any), National Service and outside erests, together with the names of two referees

UNIVERSITY OF BIRMINGHAM

ESSO STUDENTSHIPS IN CHEMICAL ENGINEERING

Applications are invited from men who hold or pect to hold a good university degree in chemi- or other branch of engineering or in chemistry two Esso Studentships, founded by the Esso troleum Company, Limited, tenable from Octo- 1955 The value of the studentships is £350 year, plus university fees

Applications should be submitted to the gistrar, University of Birmingham, Edgbaston, rmingham, 15, by June 11, 1955, giving full rticulars of educational qualifications, indusal experience (if any), National Service and tside interests, together with the names of two erees

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

LONDON, S W 7

ROYAL DUTCH SHELL STUDENTSHIP IN GEOPHYSICS

This studentship is open to honours graduates in physics or geology (with mathematics and physics at intermediate level) for a two-year course from October, 1955, in Geophysical Prospecting applied to the search for oil Value £430 per annum, less fees £60 per annum

Applications must be received before June 1 1955 Further particulars from Registrar, Imperial College, S W 7

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

ESSO STUDENTSHIP IN CHEMICAL ENGINEERING

Applications are invited from men who hold or expect to hold an honours degree in chemistry or engineering for the Esso Studentship, founded by the Esso Petroleum Company, Limited, tenable from October 4, 1955 The value of the studentship is £350 a year, plus college fees

Applications should be submitted to the Registrar, Imperial College London, S W 7, by May 13, giving full particulars of previous industrial experience (if any) National Service, and academic qualifications The names of two references should also be given

FOR SALE AND WANTED

CORNEAL AND CONTACT LENSES EASY payments arranged if desired—For details and free booklet write David Blackstone, Ltd, Dept 235, Triumph House, 189 Regent Street, London, W 1 Tel Regent 3516-7 Consulting Rooms in Leeds, York, Leicester Middlesbrough Newcastle, etc

BIOCHEM J, 1931-36, 12 VOLS BOUND maroon buckram perfect—Offers to Box 673, T G Scott and Son, Ltd, 143-147, Regent Street, London, W 1

EPIDIASCOPE IN NEW CONDITION complete with case and spare lamps, £62—Russell, "Byeways," Knowl Hill near Twyford, Berks Phone Littlewick Green 269

MISCELLANEOUS

THE ROYAL INSTITUTE OF CHEMISTRY

Founded 1877 Incorporated by Royal Charter 1885

APPOINTMENTS REGISTER

A Register of Chemists (Fellows, Associates, and Senior Registered Students) who are available for appointments, or who are seeking to improve their positions, is kept at the office of the Institute The facilities afforded by this Register are available (free) to Companies and Organizations requiring the services of chemists and to Universities, Colleges, and Technical Schools, requiring Teachers of Chemistry and Technology

Particulars of the Regulations and Examinations of the Institute can be obtained (free) on application to the Registrar, The Royal Institute of Chemistry, 30 Russell Square, London, W C 1

UNIVERSITY COLLEGE, DUBLIN, AND INSTITUTE OF CHEMISTRY OF IRELAND

"SYMPOSIUM ON RECENT ADVANCES IN THE CHEMISTRY OF NATURALLY OCCURRING PYRONES AND RELATED COMPOUNDS"

The Symposium will be held in the Department of Chemistry, University College, Dublin on July 12 to 14, 1955 The following have accepted invitations to participate Professor J Algar (Dublin), Dr R G R Bacon (Belfast), Professor W Baker, F R S (Bristol), Dr E C Bate-Smith (Cambridge), Professor H Erdtman (Stockholm), Professor K Freudenberg (Heidelberg), Professor S Hattori (Tokyo), Professor F E King, F R S (Nottingham), Dr W D Ollis (Bristol), Professor H Schmid (Zurich), Professor T R Seshadri (Delhi), Dr T H Simpson (Aberdeen) Professor K Venkataraman (Bombay), Dr W B Whalley (Liverpool), Professor T S Wheeler (Dublin), Dr G Woker (Berne)

Those wishing to attend this Symposium are requested to communicate with Dr Eva M Philbin, Department of Chemistry, University College, Dublin The registration fee is ten shillings (10s) The programme will be sent to those registered

MATHEMATICS PRIVATE COACHING for B Sc—Write E Foster, 41 Belsize Square, London N W 3

HIGH SPEED VIBRATION MILL
(100 *C.P.S.*), ideal for KBr disk technique and other fine and fast grinding

ROTATING ELECTRODE (*graphite disk*) **SPARK UNIT** for the study of lubricating oils, other liquids and powders

Descriptive literature on application

RESEARCH & INDUSTRIAL INSTRUMENTS CO.
1 Laycock Street, Islington, London, N 1 ARChway 5488

INFRA-RED CELLS

Variable path-length cells for liquids

Fixed path-length cells for liquids and gases

(Made by Research & Industrial Instruments Co)

Catalogue CH388/N 3 free on application from

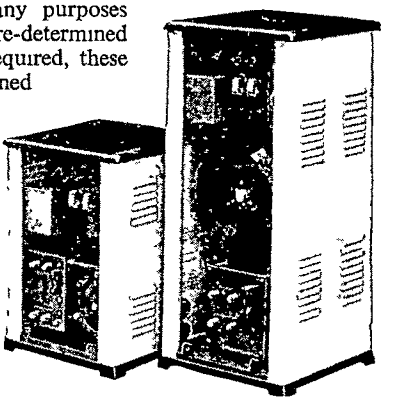
HILGER & WATTS LTD.
98 St. Pancras Way, London, N.W.1

ZENITH
(REGD TRADE-MARK)

Automatic

VOLTAGE REGULATORS

with Electronic Control



Essential for many purposes where a constant pre-determined supply voltage is required, these Regulators are designed to give a controlled output voltage within 1% with input voltage variations up to plus or minus 10% Manufactured for single- and three-phase loads from 5 up to 23 kVA per phase

Illustrated brochure free on request

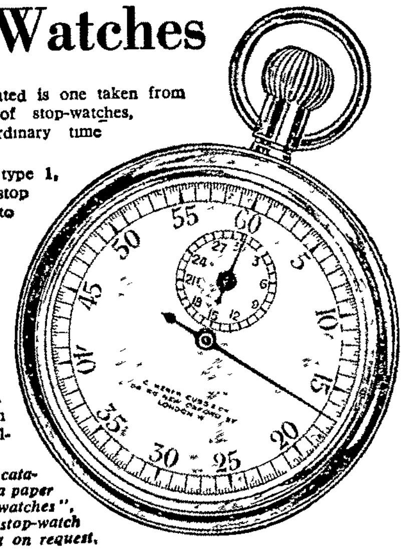
The ZENITH ELECTRIC CO. Ltd.
ZENITH WORKS, VILLIERS RD, WILLESDEN GREEN
LONDON, N W 2
Phone WILlesden 6581-5 *Grams* Voltaohm, Norphone, London
MANUFACTURERS OF ELECTRICAL ENGINEERING PRODUCTS
INCLUDING RADIO AND TELEVISION COMPONENTS

Director *for the Textile Research Institute, Bombay*

Applications are invited for the post of Director of the Textile Research Institute, Bombay, which will deal with fundamental and applied research in all branches of the cotton textile industry. The candidates must be physicists, chemists or textile technologists with an outstanding record of research Administrative experience and evidence of ability to plan laboratories and to organize and direct an extensive programme of research will be important considerations. Remuneration will be commensurate with the high responsibility of the post. The Director will be provided with a residence at a nominal rent, will receive a car allowance, and will be entitled to provident fund benefits The appointment will be for a period of five years in the first instance

Applications (6 copies) must reach the Secretary, Millowners' Association, Veer Nariman Road, Bombay, 1, India, not later than June 1, 1955

Stop Watches



THE stop-watch illustrated is one taken from our new catalogue of stop-watches, chronographs and ordinary time of day watches

It is Model 01—a type 1, three-pressure action stop watch, recording up to 30 minutes One revolution of the large hand equals 60 seconds

In view of its relatively low cost and high accuracy the watch is very suitable for general laboratory use A 1/10th second watch model 03 is also available

A copy of our new catalogue, which includes a paper " Some notes on stop watches ", is of interest to all stop-watch users and will be sent on request.

Guaranteed repairs Timing service Certification

Tachometers Time Interval Meters

CAMERER CUSS

Timing Division

Makers of Good Clocks & Watches since 1788

AT

NEW OXFORD STREET, LONDON, W C.1

MUSeum 8968/9

Our only other address 91 Kingsway, W C 2

ISOTOPE

HANDLING EQUIPMENT—SHIELDING

H L INSTRUMENTS LTD

43 POOLE ROAD BOURNEMOUTH

WESTBOURNE 65077

BRASS • COPPER • DURAL • ALUMINIUM • BRONZE •

ROD, BAR, SHEET, TUBE, STRIP, WIRE

3,000 STANDARD STOCK SIZES

No Quantity too small • List on application

H. ROLLET & CO., LTD.

6, CHESHAM PLACE, LONDON, S W 1. SLOane 3463

Also at LIVERPOOL, LEEDS, MANCHESTER, BIRMINGHAM

HIGH VACUUM STOPCOCKS

Individually Tested and Guaranteed

(A E R E Harwell approved)

New Catalogue on request to

G. SPRINGHAM & Co. Harlow New Town

"The Stopcock People" HARLOW 24108

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE

FROM LIVER OR YEAST

and other SIGMA brand products are now available

Ask for list SIGMA 8

GEORGE T. GURR LTD.

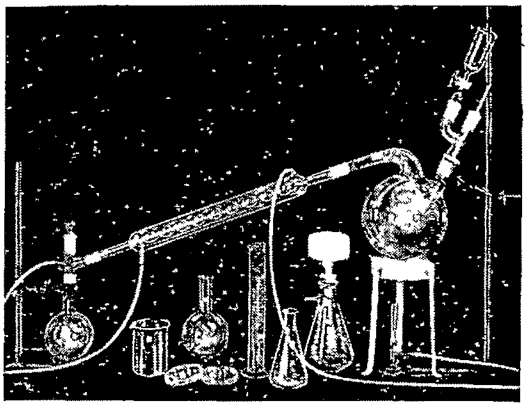
136-138 NEW KINGS RD, LONDON, S W 6

The Microscopical Stain People

Glass apparatus to your specification

Your general Laboratory Glassware and Requisites

THE SCIENTIFIC GLASSBLOWING CO. LTD.
95, GRAY'S INN ROAD, LONDON, W.C.1
Telephone . HOLBORN 4228



TRADE JAYGO MARK

Special & Standard Scientific Apparatus & Glassware

GLASS EQUIPMENT FOR FUME ABSORPTION

◆

LABORATORY HOSPITALS AND PILOT PLANT EQUIPMENT FOR ANALYTICAL EDUCATIONAL AND RESEARCH PURPOSES

◆

THE JAGO COMPANY
90 RUSHOLME ROAD, MANCHESTER, 13

MANSFIELD OIL-GAS PLANT FOR LABORATORIES' GAS SUPPLY

- *Reliable* • *Simple to Operate* • *Safe*

Provides a gas supply at a constant calorific value of 1,350 B.T.U.'s per cu. ft. produced from Light Diesel Oil, Gas Oil, Paraffin, or other suitable oils available at low cost.

Enables the efficient use of a full range of modern gas burning appliances in any part of the world. Ideal for glass blowing and gives perfect oxidising or reducing flames with ordinary atmospheric burners.

For full particulars send details of estimated number of burners to be used.

MANSFIELD & SONS LTD.
62 HAMILTON SQUARE, BIRKENHEAD

TINSLEY POLAROGRAPHS

FOR RAPID AND ACCURATE CHEMICAL ANALYSIS

RECORDING AND DIRECT-READING MODELS BOTH WITH DERIVATIVE CIRCUITS

YOU ARE INVITED TO USE OUR POLAROGRAPH INFORMATION SERVICE

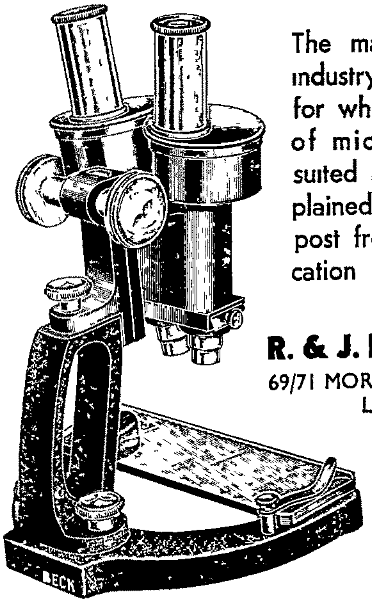
PLEASE WRITE FOR PUBLICATION NA. 287

EVERSHED

EVERSHED & VIGNOLES LTD.
ACTON LANE WORKS · CHISWICK · LONDON W4
TELEPHONE: CHISWICK 3670 TELEGRAMS: MEGGER, CHISK, LONDON
CABLES: MEGGER, LONDON

BECK

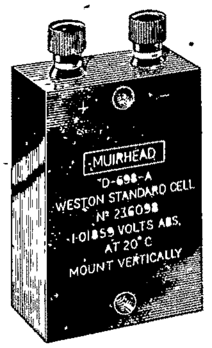
LOW POWER BINOCULAR MICROSCOPES



The many uses in industry and science for which this type of microscope is suited are fully explained in booklet, post free on application

●

R. & J. BECK Ltd.
69/71 MORTIMER STREET
LONDON, W 1



A New Standard Cell by MUIRHEAD

£3.0.0

(Post free in U K)

D-698 WESTON STANDARD CELL

This new cell combines the robustness and small size of our D-550 Miniature Standard Cell with a high capacity previously only obtainable in larger and more expensive types such as our D-402

Whether you require a standard of E M F for an industrial application or for laboratory use, this new cell will meet your needs and give many years of reliable service

SPECIFICATION

E M F	1 01859V+110μV −90μV at 20°C
Temperature coefficient	−0 00004 per °C
Discharge rate	Up to 20μA for short periods
Internal resistance	600 ohms
Overall dimensions	1 15/16″ x 1′ x 3 3/8
Weight	4 oz

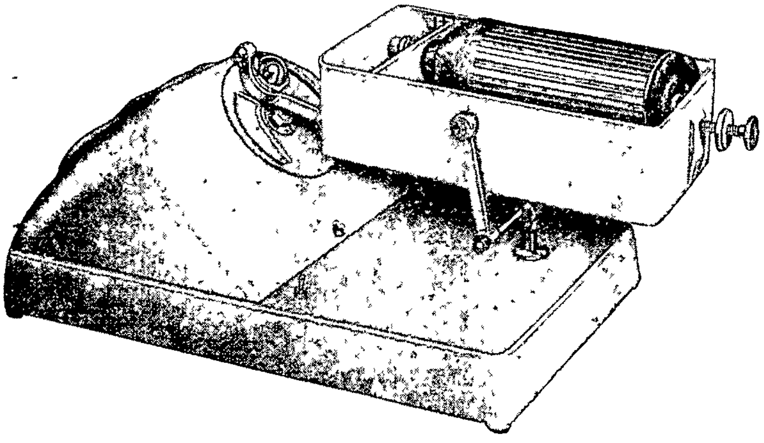
Our D-550-A and D-402 Weston Standard Cells are still available

WRITE UNDER YOUR BUSINESS LETTERHEAD FOR PUBLICATION 5716

MUIRHEAD & CO. LIMITED BECKENHAM KENT ENGLAND
PRECISION ELECTRICAL INSTRUMENTS 147

a new development . . . **SUPER-SHAKER**

Gallenkamp REGD.



The shaking effect is quite remarkable and is achieved by the novel mechanism which imparts a three-dimensional movement to bottles not unlike that obtained by hand but far more vigorous The movement can be described as a violent reciprocation accompanied by a twisting up and down motion and the contents of bottles are shaken very thoroughly

Please apply for publication No. 561

A. GALLENKAMP & CO. LTD., 17-29, SUN STREET, LONDON, E.C.2

Printed in Great Britain by Fisher, Knight & Co , Ltd , The Gainsborough Press, St Albans, and published by Macmillan & Co , Limited, at St Martin's Street, London, W C 2, and St Martin's Press, Inc , 103 Park Avenue, New York 17, N Y , U S A —Saturday, March 19, 1955

SUPPLEMENT: RECENT SCIENTIFIC AND TECHNICAL BOOKS

NATURE

'To the solid ground
Of nature trusts the Mind that builds for aye'—Wordsworth

VOL. 175, No. 4456 SATURDAY, MARCH 26, 1955 TWO SHILLINGS

21/4/55

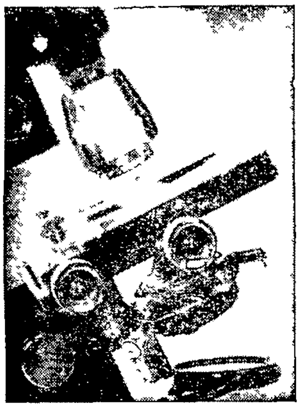
THE Newton

LONG WORKING DISTANCE ATTACHMENT

. . . provides a working distance of 12·8 mm. between object glass and specimen when fitted to a standard microscope in conjunction with a conventional 4 or 8 mm objective

A further important feature is that the use of this attachment eliminates image reversal and thus further facilitates examination and manipulation of specimens

Write for further details to: Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, 17
Member of the A.E.I. Group of Companies N/A 101

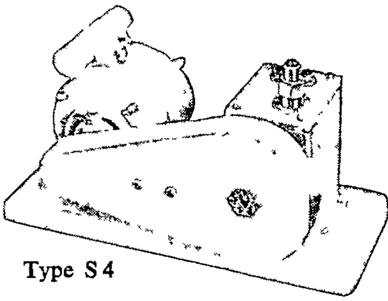


METROVAC PUMPS

Typical of the Metrovac range of rotary pumps, the Type S 4 has a displacement of 0.4 litres/sec.

Other models cover the range up to 33 litres/sec.

Please write for full details.



Type S 4

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

Member of the A.E.I. group of companies

VACUUM PUMPS

N/P402

Temperature Measurement

Send for lists on—

Mercury-in-Steel Thermometers (LIST T/40)
Electrical Thermometers (LIST E/30)

Post free on request

Negretti & Zambra, Ltd., 122 REGENT STREET, W.1 REGent 3406

Manufacturers of instruments for the indication, recording and controlling of—temperature, pressure, liquid level, volume, specific gravity, humidity, etc.

BRANCHES: *Birmingham • Cardiff • Glasgow • Leeds • Manchester • Nottingham*

AGENTS OVERSEAS: *Argentina • Australia • Belgium • Canada • Czechoslovakia • Denmark • Egypt • Eire • Finland • France • Greece • Holland • Iceland • India • Italy • New Zealand • N. Ireland • Norway • Portugal • S. Africa • Spain*

Technical Service available in most countries

A VITAL Service ... behind SUCCESSFUL VACUUM PROCESSI

The importance of employing the correct grade and high quality oil, grease or wax in high vacuum work cannot be over-emphasized Indifferent performance of vacuum pump, failure of waxed and greased joints, excessive de-gassing, etc . . . nearly always stems from materials which are unsupported by adequate preparation and research.

- **"APIEZON" (regd.) Produc**

  Oils Low vapour pressure oils for high-sp vapour pumps sealing and lubricating for all types of high vacuum taps and join *Greases* For sealing ground glass vac joints Suitable for thermionic experime etc

  Also a wide range of sealing compour waxes and cements

  "Apiezon" is a registered trade mark of Api Products Ltd

- **Edwards Rotary Pump Oils.**

  Special grades for standard high vacu rotary pumps and gas-ballast (air-injecti types

  Also EDWARDS special grade 'Boos vapour pump fluids

  A wide range of waxes, greases, ceme

- **Silicone Fluids.**

  Vapour Pump Fluid Remarkable stabil Do not decompose when exposed to atm phere at operating temperatures Hig resistant to chemicals

  Silicone Vacuum Greases Non-volat chemically inert and heat stable Ideal all vacuum taps and joints

W. EDWARDS & CO (LONDON) LTD for better vacuum service

MANOR ROYAL · CRAWLEY SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES GLASGOW & TORONTO AGENTS THROUGHOUT THE WORLD

CASELLA LONDON

CHATTOCK-FRY TILTING MANOMETER

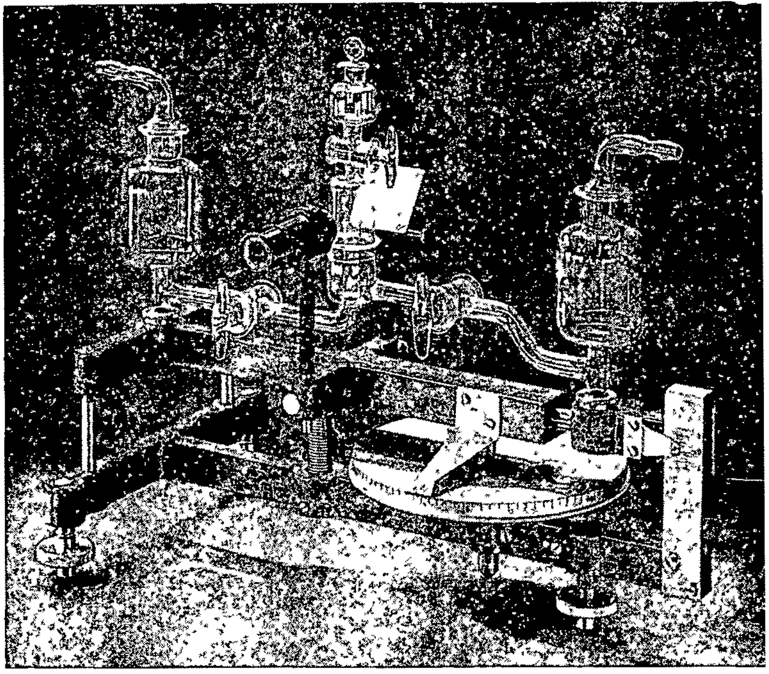
A High-Sensitivity Instrument

Range 0.65 in. w.g.
Reads to 0.00065 in. w g

This gauge is available for immediate delivery, and further details may be obtained on request to:

C. F. CASELLA & CO. LTD.
REGENT HOUSE
FITZROY SQUARE
LONDON, W.1
Telephone ★EUSton 3944

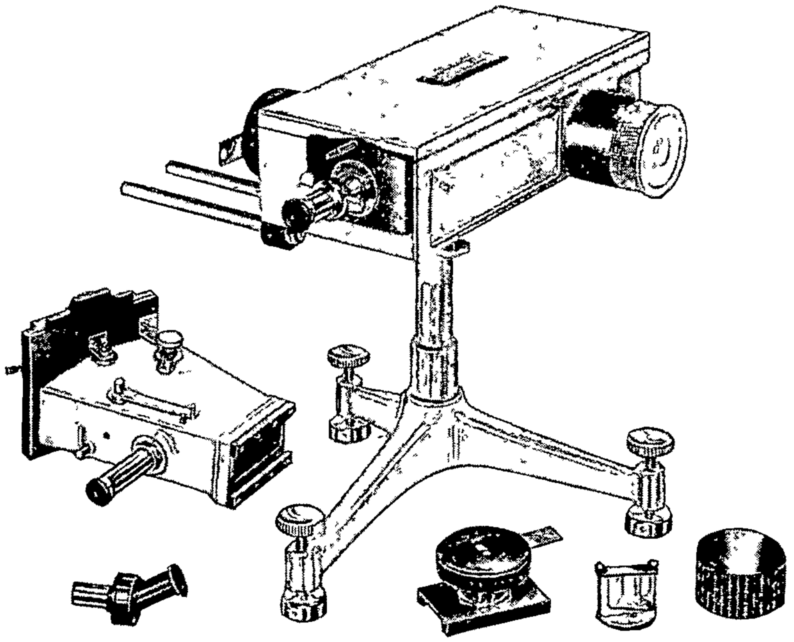
Member Scientific Instrument Manufacturers' Association of Great Britain



PRECISION INSTRUMENTS

Direct Reading Wavelength Spectrometer

For use in the visible spectrum and also, when required, in the ultra violet and infra red. Reading in wavelengths directly



A camera attachment can be supplied giving the following length of spectrograms:

With quartz prism, wavelength 10,000A to 2,200A, 70 mm.

With glass prism, wavelength 10,000A to 3,600A, 125 mm.

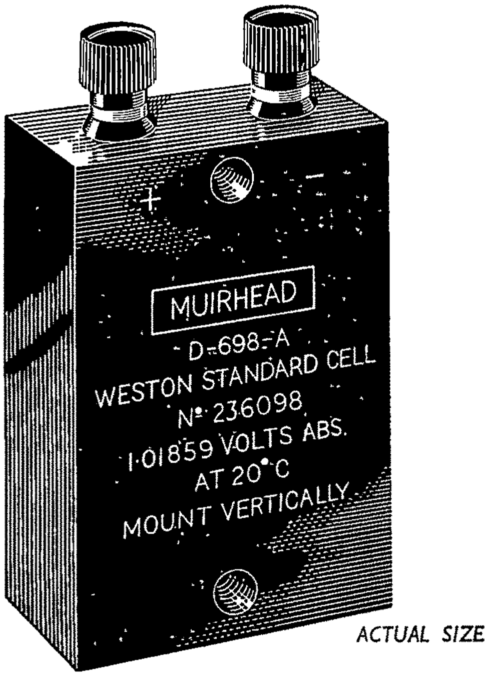
DELIVERY AT SHORT NOTICE

The large range of accessories which can be supplied with this spectrometer make it a really universal instrument, and our staff are at your service at all times to recommend the equipment most likely to suit your needs.

Full particulars from the makers:

Bellingham & Stanley Ltd.

DEPT. N, 71 HORNSEY RISE, LONDON, N.19
PHONE: ARCHWAY 2270



ACTUAL SIZE

A New Standard Cel

by

MUIRHEAD

£3.0.0

Post free in U.K.

D-698 WESTON STANDARD CEL

This new cell combines the robustness and small size of our D-550 Miniature Standard C with a high capacity previously only obtainable in larger and more expensive types su as our D-402

Whether you require a standard of E.M.F. for an industrial application or for laboratory us this new cell will meet your needs and give many years of reliable service.

SPECIFICATION

E.M.F.	1.01859V+110μV−90μV at 20°C.
Temperature coefficient	−0.00004 per °C.
Discharge rate	Up to 20μA for short periods
Internal resistance	600 ohms
Overall dimensions	$1\frac{15}{16}''$ x $1''$ x $3\frac{3}{8}''$
Weight	4 oz

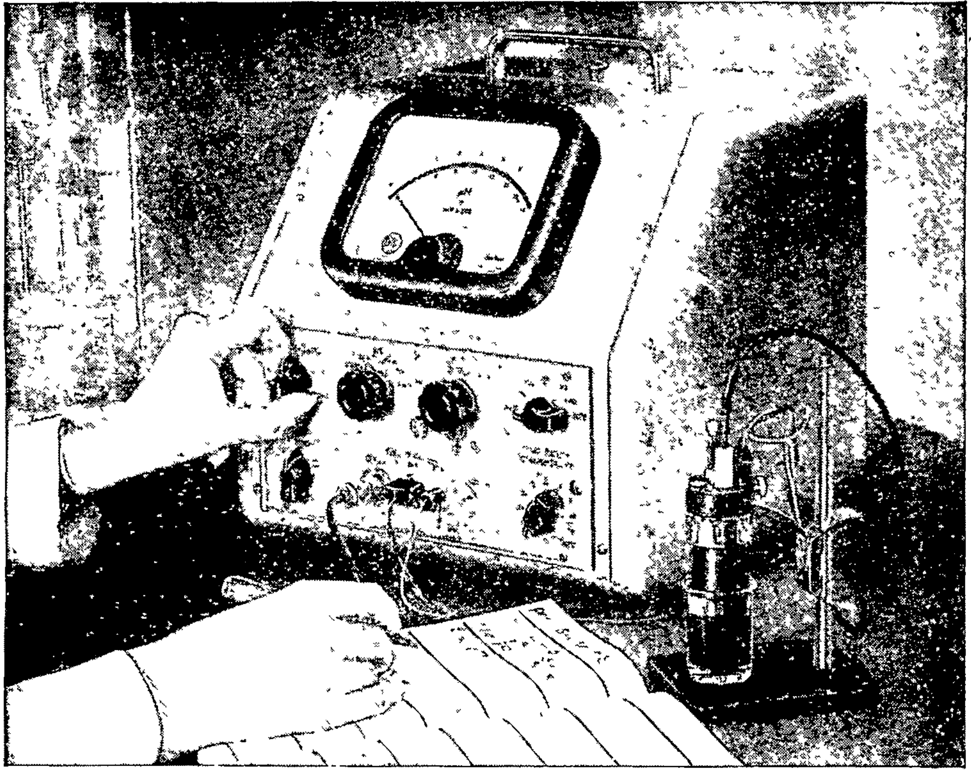
Our D-550-A and D-402 Weston Standard Cells are still available

MUIRHEAD

PRECISION ELECTRICAL INSTRUMENTS

WRITE UNDER YOUR BUSINESS
LETTERHEAD FOR
PUBLICATION 5716

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAN



A tropicalised version of the PYE UNIVERSAL pH METER & MILLIVOLTMETER is in full production

LOOK TO pH

★ for economies in the consumption of re-agents.
★ as the key to new products.
★ as a means of controlling quality.
★ as the answer to effluent problems
★ as the vital parameter in chemical and medical research

LOOK TO PYE FOR pH

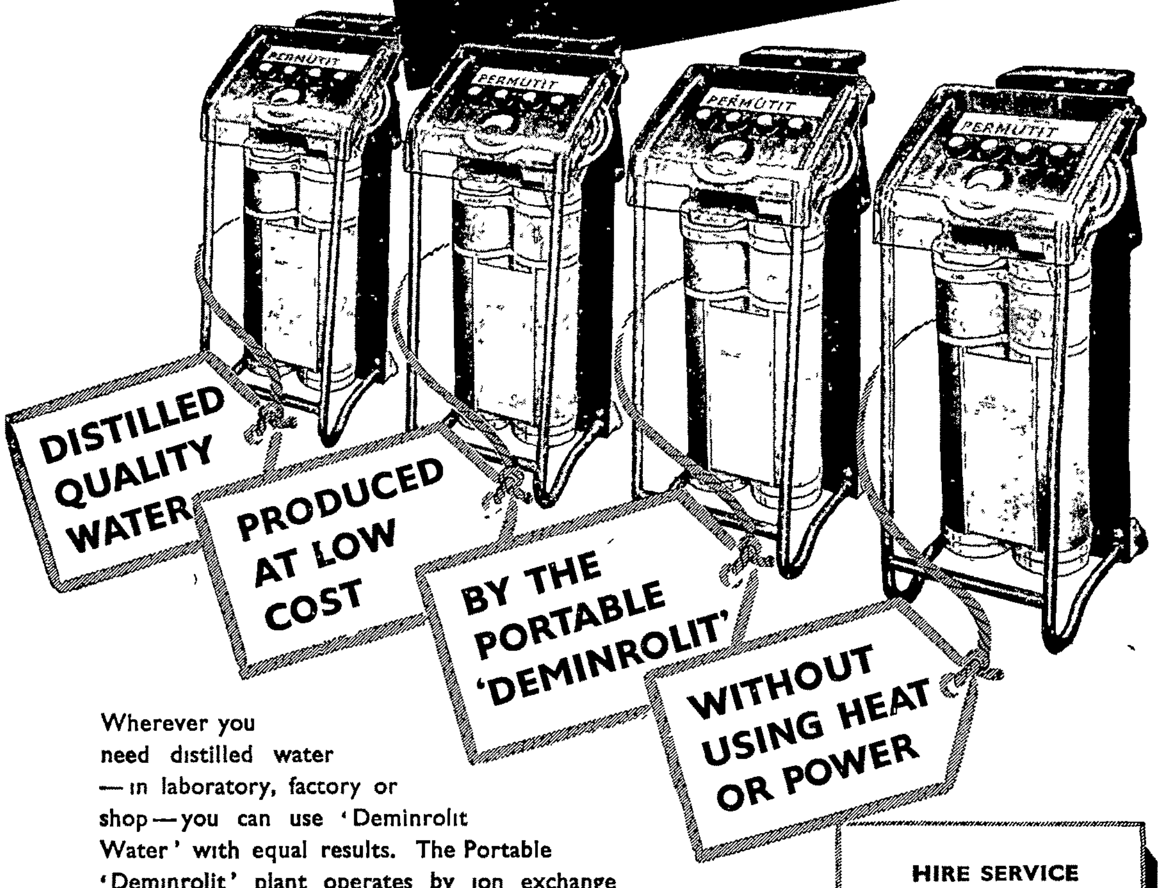
Pye offers a comprehensive advisory service and maintains facilities to carry out experimental work on new pH problems Please write to our pH department for details of our range.

SCIENTIFIC PYE INSTRUMENTS

W. G PYE & CO. LTD, GRANTA WORKS, CAMBRIDGE, ENGLAND

W G 50

DISTILLED QUALITY WATER



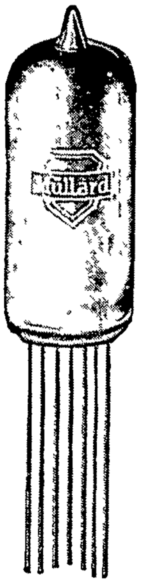
Wherever you need distilled water — in laboratory, factory or shop — you can use 'Deminrolit Water' with equal results. The Portable 'Deminrolit' plant operates by ion exchange and delivers water substantially free from dissolved solids. Running costs are measured in pence instead of in pounds, and you can thus use distilled quality water for many purposes where the cost of distillation would prove prohibitive
Please write for Technical Publication No. 62 which gives full details.

HIRE SERVICE

Why not try demineralised water in your industry? You can do so easily and cheaply by hiring from us, at a nominal rental for a trial period, the latest Mark II Model Portable 'Deminrolit' Plant. Details of this service will gladly be supplied on request.

PERMUTIT 'DEMINROLIT'

THE PERMUTIT COMPANY LIMITED
(Dept. V.H. 173), Permutit House, Gunnersbury Avenue, London, W.4. *Telephone : CHIswick 6431*



High Performance

VOLTAGE STABILISERS
and
REFERENCE TUBES

Close tolerance burning voltages
Wide range of operating temperature
Good stability over life
Freedom from output voltage "jumps"
Long operating life

NOW

ALSO AVAILABLE IN
SPECIAL QUALITY RANGE

The high performance of Mullard stabilisers has been improved even further by the introduction of *Special Quality* types, which will operate satisfactorily under rigorous conditions of shock and vibration. These special versions of normal production types combine extra-rugged construction with what has proved to be an inherently reliable principle of design, and they will be available in addition to the normal range.
Samples selected from every production batch of *Special Quality* tubes are tested against Services' specifications to withstand impacts of 500g and vibration of 6g at 175 c/s
All three of the *Special Quality* tubes can be supplied with either pin or flying lead bases Your enquiries for further details of these and other stabilisers in the Mullard range are welcomed at the address below.

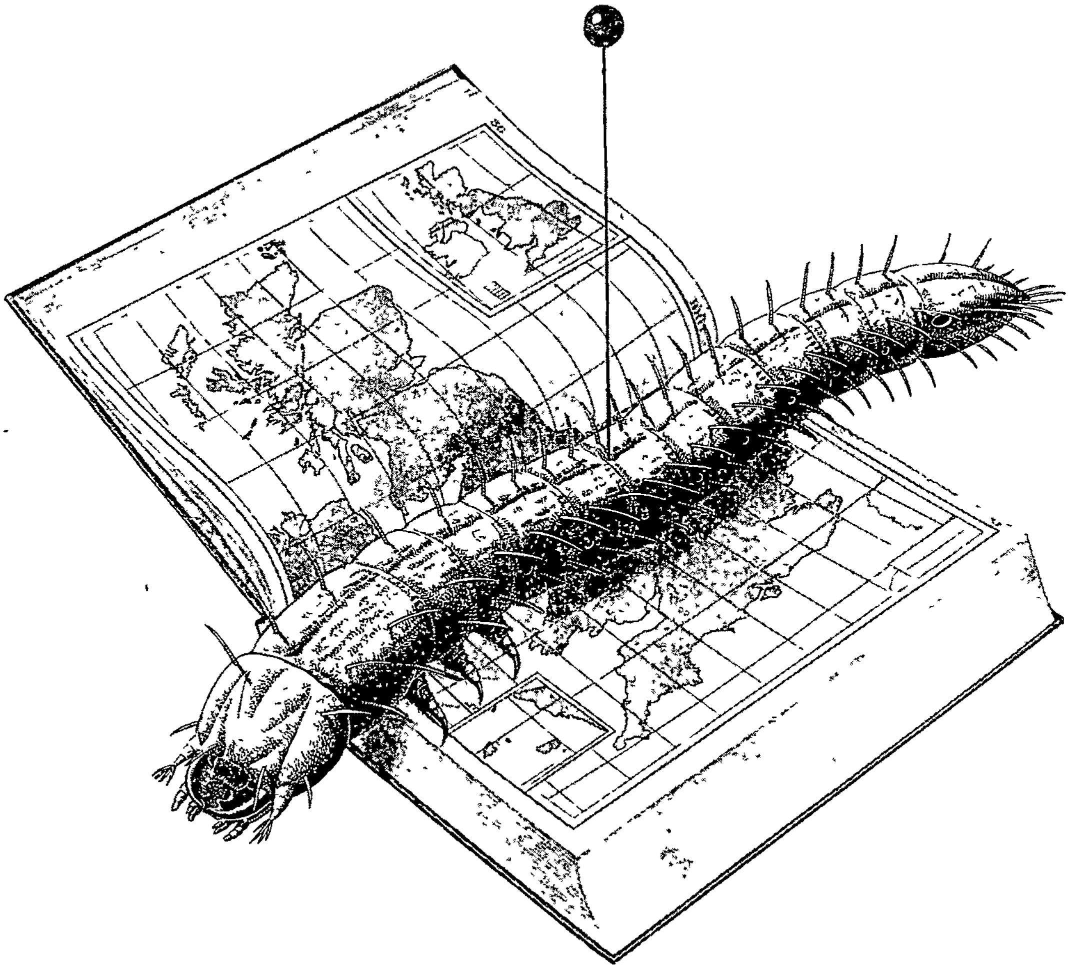
Special Quality Type No.		Electrical Equivalent		Burning Voltage (V)	Current Range (mA)	Maximum Ignition Voltage (V)
Pin Base	Flying lead Base	Mullard	British Services			
M8098	M8142	85A2	CV449	85	1 to 10	115
M8206	M8207	90C1	—	90	1 to 40	115
M8163	M8208	150B2	CV2225	150	5 to 15	180

Mullard
SPECIAL QUALITY
VALVES

Mullard

MULLARD LTD, COMMUNICATIONS & INDUSTRIAL VALVE DEPT, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W C 2

MVT 170



The case of *Agriotes obscurus* . . .

Wherever potatoes are grown, wireworms are pretty certain to be encountered and to damage the tubers In the U K , for example, this destructive pest populates the soil in some areas to the extent of over a million per acre. In heavy local infestations this figure is probably doubled Damage fluctuates, but it is nothing unusual to find over half a crop unfit for the table

With wireworms on the increase, British farmers have welcomed the arrival of aldrin This year in the United Kingdom alone over 90,000 acres of potatoes will be protected, mostly with aldrinised fertilizer This Shell insecticide is the most impressive destroyer yet discovered for pests in the soil—non-tainting and exceptionally suitable for compounding with fertilizer

Just 2½ lbs of aldrin per acre guards potatoes from wireworm and other soil pests right through the growing season

Aldrin is fast becoming recognised as being the best of all soil insecticides A little goes a long way and lasts a long time Now in world wide use, aldrin gives full control of many pests previously difficult to 'get at' economically

Another recently developed Shell insecticide is dieldrin *possessing exceptional persistence On foliage,* dieldrin *controls a very wide range of weevils, beetles, flies and other crop-eating insects It is also extensively used as a residual spray against disease-carrying insects*

Have you a stubborn pest problem to be solved?

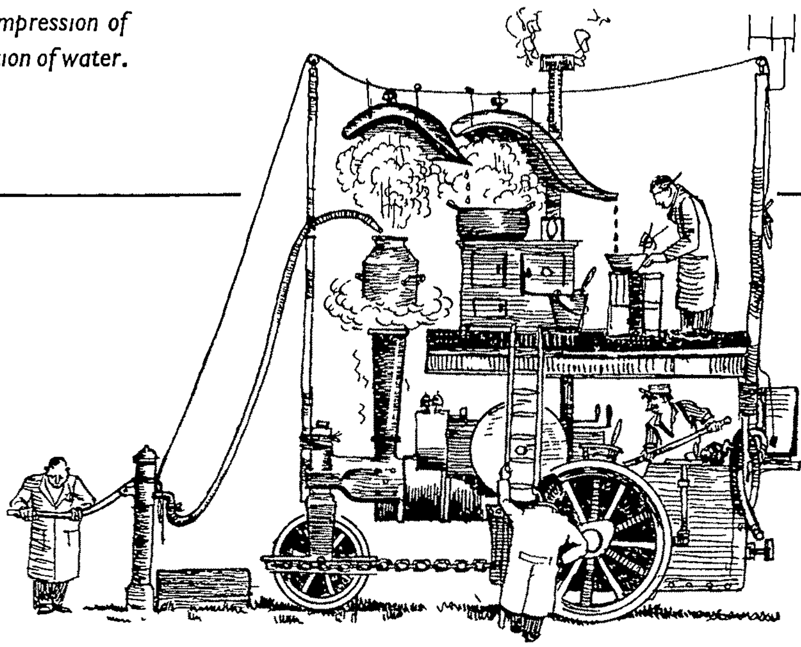
aldrin

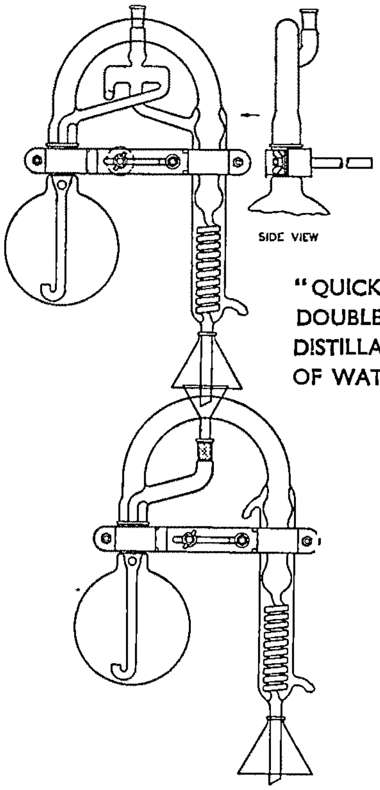
aldrin and dieldrin are SHELL insecticides for world wide use

For further information apply to your Shell Company

Issued by The Shell Petroleum Company Limited, London, E C 3, England

ur cartoonist's impression of
ıe double distillation of water.





"QUICKFIT"
DOUBLE
DISTILLATION
OF WATER

The quicker way
is the
"QUICKFIT" way !

Standard "Quickfit" apparatus is made for the laboratory production of the highest quality distilled water by double distillation This assembly is specially designed for continuous automatic distillation It is capable of an output of two litres per hour, at an economical cost It is as foolproof as it is efficient

UICKFIT & QUARTZ Ltd

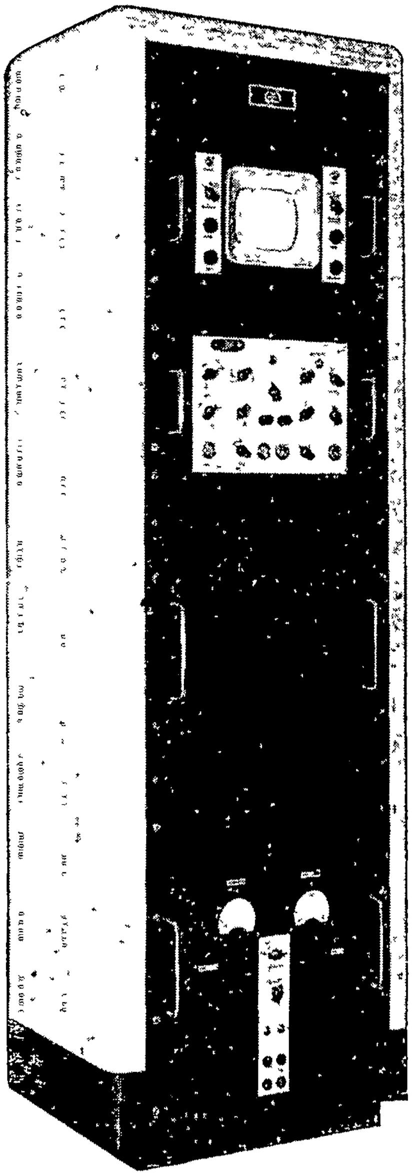
INTERCHANGEABLE LABORATORY
GLASSWARE

Dept. Z.W., "Quickfit" Works,
Heart of STONE, Staffs.
Telephone: Stone 481

British
Instrument
Industries
Exhibition
Earl's Court
28th June–19th July
Stand No. 19
Block No C.

PROGRESS IN CONTROL

SUNVIC
PULSE HEIGHT
ANALYSER



An instrument for the analysis of a complex pulse amplitude spectrum into groups of known height according to their voltage amplitude.

It displays up to a maximum of 120 channels and can store 1,200 binary digits. The design is based on that of Hutchinson & Scarrott (*Phil Mag*, 42, 792, 1951) and the instrument is made under licence from the N R D.C

EQUIPMENT BY SUNVIC

SUNVIC CONTROLS LTD (*Special Products Division*), *No. 1 Factory, Eastern Industrial Estate, Harlow, Essex.* **Telephone: Harlow 24231/**
Manufacturers of Pneumatic and Electrical Instruments for detection, measurement, control and recording of Temperature, Flow, Liquid Level
Specific Gravity and Pressure, in Science and Industry. Vacuum Pumping and Measuring Equipment, etc.
Member of the A.E.I. Group of Companies

TAS/Sc 30

CASEIN

LOW VITAMIN CONTENT

IN THE FIELD OF RESEARCH on animal nutrition a Casein of low vitamin content is required as a vitamin-free animal protein base *Casein — low vitamin content* — as supplied by Whiffens, has a protein content of not less than 90%. The process by which it is made is designed to remove both fat and water soluble vitamins, making the product suitable for the usual biological depletion procedures. It conforms to the following general specification:—

Appearance	**Cream coloured powder**
Loss at 100°C	**Not more than 5%**
Protein (by Nitrogen)	**Not less than 90%**
Ash	**Not greater than 2.0%**
Aneurine Hydrochloride	**Not greater than 1 pt. per million**
Riboflavin	**Not greater than 0.25 pt. per million**
Nicotinic Acid	**Not greater than 1 pt. per million**
Pantothenic Acid	**Not greater than 0.75 pt. per million**

Analyses of individual batches are available on application.
Available in units of 3 Kgs packed in hermetically sealed tins

Each consignment of CASEIN-LOW VITAMIN CONTENT is identified by a batch number

WHIFFENS

fine chemicals for industry

WHIFFEN & SONS LTD, NORTH WEST HOUSE, MARYLEBONE ROAD, LONDON, N W 1 TELEPHONE PADDINGTON 1041/9
TELEGRAMS WHIFFEN, NORWEST, LONDON

To the analytical chemist the Spectrophotometer is a third eye, investigating the infrared, visible and ultraviolet regions of the spectrum and disclosing precise information with ease and speed. New horizons are thus revealed to the research worker and the technologist alike. An account of these leading instruments and of some typical applications will gladly be supplied by Unicam Instruments of Cambridge.

UNICAM
SPECTROPHOTOMETERS

NATURE

No. 4456 SATURDAY, MARCH 26, 1955 Vol 175

CONTENTS

Page
Interpretation of Scientific Progress 521
Prehistory of Africa By Abbé H Breuil 523
Connective Tissue By Dr G H Bourne 524
Geological History of California By Dr W E Swinton 525
Instability of the Earth's Axis of Rotation. By T Gold 526
Scientific Intelligence and Defence By Chapman Pincher 529

Obituaries

Sir Edward Mellanby, G B E, K C B, F R S By Prof B S Platt, C M G 530
Prof J K. Parnas By Dr T Mann, F R S 532
New Fellows of the Royal Society 533
News and Views 534
Organization of Applied Research By Dr D W Hill 538
Aeration in Industrial Fermentations 539
Trend and Pattern of Fertility in Great Britain 540
National Research Development Corporation Report for 1953–54 541
Central Laboratories for Scientific and Industrial Research, Hyderabad Report for 1953 542
Imperial College of Science and Technology, London Report for 1953–54 542
A Simple Method for studying and demonstrating the Energy Consumption in Flying Insects By Dr Olavi Sotavalta 543
Resistivity in Metals By H G van Bueren and P Jongenburger, P Jongenburger 544
Induction Periods and Ignition Limits in Sensitized Ignitions of Hydrogen and Oxygen By Prof R G W Norrish, F R S, Dr P G. Ashmore and Prof F S Dainton 546

Letters to the Editors

Cephalosporin C, a New Antibiotic containing Sulphur and D-α-Aminoadipic Acid —G G F Newton and Dr E P Abraham 548
An Infectious Nucleoprotein from Tobacco Mosaic Virus —By Prof G Schramm, G Schumacher and W Zillig 549
Cellular Control in Virus Infection —Prof P M de Burgh and J F A P Miller 550
A Mechanism for Citrate Dissimilation —S Dagley and Dr E A Dawes 550
Production of Pyruvate from 6-Phosphogluconate by Bacterial Plant Pathogens and Legume Bacteria —H Katznelson 551
Inhibiting Effect of Trypan Blue on the Experimental Production of Liver Cancer —S Iwase and K Fujita 552
Determination of the Life of Human Blood Platelets using Labelled Diisopropylfluorophosphonate —C H W Leeksma and Dr J A Cohen 552
Plant Hyperplasia induced with a Cell-free Insect Extract —Donald Leatherdale 553
Colloid Osmotic Pressures of Dextran, Serum and Dextran–Serum Mixtures —D S Rowe 554
Separation of Flavins by Ion-Exchange Resins —K Yagi, J Okuda and Y Matsuoka 555
Circular Chromatography of Terpenes on Adsorbent Coated Glass —L H Bryant 556
Inverted Rhythmic Precipitation —Dr A Packter 556
Intensity Variation in Sunspots —William A Miller 557
Germanium in Power Station Boiler Plant —Dr J S Forrest, A C Smith and J M Ward 558
Longitudinal and Screw Vibrations of Beams —Prof G J Kynch 559
An Interferometer for 'Straightness' Measurement —J Dyson 559
Effect of Time of Embryo Formation on Quantitative Characters in *Drosophila* —Dr Alan Durrant 560
The Covering Reaction in a Tropical Sea Urchin —Prof N Millott 561
Breeding Systems and Compatibility in *Glyceria* —Martin Borrill 561
Arginase in Elasmobranch Muscle —J J Connell 562
Recent Scientific and Technical Books Supp viii

Editorial and Publishing Offices of Nature
MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number: Whitehall 8831. Telegrams Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T G Scott & Son, Ltd, Crown House, 143-147 Regent Street, London, W.1
Telephone Number Regent 3891

All rights reserved Registered as a newspaper at the General Post Office

CHAPMAN & HALL

Just Published

TRANSISTOR AUDIO AMPLIFIERS

by

RICHARD F. SHEA

(Laboratories Dept Electronics Division General Electric Company, U S A)

Size 9 *in* × 6¼ *in.* 219 *pages* 190 *figures* 52*s net*

SONICS

Techniques for the Use of Sound and Ultrasound
in Engineering and Science

by

THEODOR F. HEUTER AND RICHARD H BOLT

(Respectively Research Associate in Physics and Professor of Acoustics, Massachusetts Inst of Technology)

Size 9¼ *in* × 6 *in* 456 *pages* 221 *figures* 80*s net*

The Chemistry of

PETROLEUM HYDROCARBONS

(VOLUME I)

Edited by

BENJAMIN T. BROOKS CECIL E BOORD
STEWART S. KURTZ LOUIS SCHMERLING

Size 9 *in* × 6¼ *in* 664 *pages* *Illustrated* 144*s net*

37 ESSEX STREET, LONDON, W.C.2

HEAT CONDUCTION

With Engineering, Geological and Other Applications

L. R. INGERSOLL O. J. ZOBEL A. C. INGERSOLL

This important work contains discussions of many new applications of interest to engineers, geologists and geographers The authors are respectively Emeritus Professor of Physics, University of Wisconsin; Retired Member of the Technical Staff, Bell Telephone Laboratories, New York, and Assistant Professor of Civil Engineering, California Institute of Technology

344 pages *54 Text Figures, 23 Tables* *32s 6d net*

ELECTRIC POWER TRANSMISSION

The Power System in the Steady State

J. ZABORSZKY J. RITTENHOUSE

Specifically designed to give a broad coverage of the steady operation of transmission lines and power systems, as well as the methods available for the study of such operation, this book is equally useful for practising engineers and advanced students The authors are Professor and Associate Professor of Electrical Engineering, University of Missouri

690 pages *368 illustrations* *70s net*

THAMES AND HUDSON

244 High Holborn, London, W C 1

INTERPRETATION OF SCIENTIFIC PROGRESS

AS has already been noted in these columns (*Nature*, March 12, p. 439), Dr J. H Hilde- and's recent address to the American Philosophical ciety puts both the social responsibility of the ientist and the question of security in their proper rspective as involving problems in communication d in human relations. While, however, those prob- ms of human relations have been discussed compara- vely fully—for example, in such books as those of of W Gellhorn, Alan Barth and Prof H S Com- ager, and in relation to particular individuals like r J. R Oppenheimer, Dr. A V. Astin and Prof wen Lattimore—the problems of communication ve received nothing like adequate attention Such oblems, however, have a vital bearing on the ccess of any security programme based on those sitive conceptions of security which are expressed the recent statement from the American Association r the Advancement of Science

This problem of communication has been discussed om slightly different aspects in three recent addresses· H. L. Dryden's talk on the scientist in contem- rary life before the Cosmos Club, Washington, on ovember 16 , in Dr. J. R Oppenheimer's address at e concluding celebrations of the bicentenary of the unding of Columbia University on December 26 , d in the public lecture on "Science and Citizenship" hich Dr. Eric James delivered at the annual meeting the Science Masters' Association on December 29 ll three addresses were concerned with the isolation the scientist from the community and the way in hich effective communication could be established, us eliminating the dangers which this isolation reatens both in defence and in the effective appli- tion of science to national welfare and development.

Dr Oppenheimer's address was ostensibly on what d been chosen as the main theme of the Columbia niversity anniversary celebrations of the past year, mely, "Man's Right to Knowledge and the Free se Thereof" ; but he dealt more specifically with e prospect in the arts and sciences, and above all e emphasized the isolation of the specialist from the oad path of human knowledge and intercourse ith more means of communication than ever before, e can speak to each other less easily and less fectively. While more people are engaged in ientific research to-day, more books are published r head in Britain than in the United States, the cial sciences are pursued actively in America, andinavia and Britain, and more people both hear d compose music and paint, the frontiers of science e now separated by long years of study, by special- ed vocabularies, arts, techniques and knowledge om the common heritage even of the most civilized ciety The artist, too, finds it increasingly difficult achieve the community of experience, and common ays of describing it and interpreting it. The mmon sensibility and culture, the traditions and e history, the myths and the common experience hich it is his function to illuminate and to harmonize and to portray have been dissolved in a changing world.

Dr. Oppenheimer thus emphasized not simply the isolation of the scientist working at the frontier of science, but also showed that the artist and other creative workers are equally involved in this isolation. Moreover, he recognized the inevitability of the specialization of science, just as frankly as he admitted that these are heroic days in the natural sciences and likely to remain so. He emphasized also the dangers that arise when so much that is beautiful and enlightening, as in the experience of the artist, is cut off from the rest of the world. What is new, he insisted, is that in one generation our knowledge of the natural world has engulfed, upset and complemented all previous knowledge of the natural world Our techniques of communication and production and multiplication are new So are also the global quality of the world, our knowledge and sympathy with remote and diverse peoples, our practical involvement with them and our commitment to them in terms of brotherhood In this world in which we have come to live, the massive character of the dissolution and corruption of authority in belief, in ritual and in temporal order are also new

The difficulties which face us are thus derived from the growth of skill, of power, and of our understanding of that world, if not of the conditions which govern their exercise. To assail such changes is futile we need to recognize them and to take account of our resources , nor does Dr. Oppenheimer appear to put high among such resources the mass media of radio and television, the cinema, best-seller or the world tours of successful theatrical productions Although art and science may be purveyed by such means, they have also an inhumanizing influence and can easily destroy the individual sense of beauty

Dr. Oppenheimer concluded this address with a plea to keep our minds open and to keep them deep, to retain our sense of beauty and our occasional ability to see it in places which may be remote and strange and unfamiliar. This, he recognized, will be no easy task , but it is the condition of man and in this condition we can help because we can love one another. On that note he closed, and not with the emphasis on the open house, with no doors and no locks, of which he spoke in his Reith Lectures a year earlier The open access to knowledge may still be recognized as a fundamental freedom and as one barely compatible with modern political tyranny , but there is less confidence in our ability to achieve the harmony between knowledge in the sense of science and the community of man The secrecy—the bonds of man's own making—threatens the open society, the unrestricted access to knowledge, the unplanned and uninhibited association of men for its furtherance, and thereby the possibility of making a human community out of the complex, ever-growing and ever-changing, ever more specialized and expert technological world.

The brotherhood or community of which Dr Oppenheimer spoke rests on understanding, and here Dr Dryden strikes the same note. Science, he points out, has made major contributions to our spiritual life as well as provided powerful tools for shaping our physical environment. It places a high premium on intellectual honesty and on objective truth, and the successes of science and their impact on every aspect of life have captured the imagination and loyalties of many men as the only guide to truth.

Nevertheless, science is only a partial view of life—in many respects a narrow view—and the consequences of failure to understand this can be the more serious in that science is also amoral. Dr Dryden believes with A. H. Compton that our hope for the future rests in a growing understanding of the conditions for the good life of man in a world of science and technology, and the acceptance of a morality that is consistent with these conditions. It is not sufficient, however, for scientists themselves to recognize all this, and to realize their own limitations, as well as their responsibilities for the proper use of science for human welfare. These responsibilities are, in fact, the same as those of other citizens, no more, no less; and it is imperative that those responsible for the leadership of the community should be capable both of integrating the specialized knowledge which is involved in matters of public policy and also of maintaining high moral and spiritual standards.

Dr Dryden was concerned particularly with this last factor, neglect of which, for example, in the Oppenheimer case and in the case of the U.S. Bureau of Standards and the battery additive, he regarded as primarily responsible for the discord between scientists and the Government in the United States; he believes this to be much more serious in its effects than the failure of the Government to appreciate the importance of fundamental research as the basis of progress even in applied research and to provide for generous and continuous support. Once again, it is a matter of public understanding, of the understanding of the scientist by his fellow citizens, as well as of the understanding by the scientist of those public responsibilities of which Dr Eric James spoke. Moreover, in pleading for an increasing recognition of the social and moral responsibilities, Dr James was not at issue with Prof. A. V. Hill's view that there is no such thing as 'the scientific mind', but that, like all good citizens, scientists must take account of ethical considerations. Dr James was pleading rather for less complacency over present methods of education and for a more deliberate attempt to devise a system of scientific education that would produce the citizen, the Civil servant or the statesman at least as capable as those produced by the Oxford 'Greats' course.

Dr. James thinks that the means of mass communication alone, the radio and television, tend to create an uncritical, acquiescent public. This in itself threatens active citizenship and makes it accordingly the more important that the scientist and, it might be added, all those holding administrative responsibilities in government, should endeavour to disseminate information in such a wa that the ordinary educated man or woman is able t understand the social and political implications o scientific knowledge. Merely to enumerate some o the major topics discussed in Parliament this sessio would demonstrate the extent to which wise politica decisions in public policy turn on an understandin of scientific and technical issues. In matters of roa and rail transport, defence, atmospheric pollution, o nuclear power, neglect of scientific and technica factors could be disastrous. Although they are no the critical factors, at least it can be said that an policy which neglects or disregards them for som purely political party prejudice will endanger th national welfare, if not, indeed, national security.

Ignoring for the moment the extent to which th question of general education at the secondary o even the primary level is involved, we are concerned with the gradual spread of knowledge in th community through the improvement of means o communication and the disappearance of obstacl to their full employment. Dr Vannevar Bus recently spoke on these matters to the America Society of Mechanical Engineers. There is, of cours implied in that hope the assumption that with suc knowledge will come true wisdom; and whether th assumption can wisely be made depends at least in pa on the means of communication. That may well brin us right back to Dr Oppenheimer's Reith Lecture

In his book on "The Crisis in the University", S Walter Moberly rightly said that we need not onl discoverers of facts hitherto unknown but al explorers of ideas and rethinkers of values. We a concerned with the improvement as well as th extension of knowledge, and we need more thinkin about the importance of things already known. Book which throw new light on the significance and inte relations of facts already known perform a functio no less important than works of research in a narrow and more technical sense. They help us to get clos to the heart of things and sometimes give a ne meaning to familiar objects.

The most successful of the Reith Lectures ha been those which have done exactly that. Institute in 1948, these Lectures were intended to provide a opportunity for some acknowledged authority to giv listeners, in a series of some half-dozen half-hou talks, the results of study or research on some chose theme. It was hoped that such a series of serious talk would add to the pool of knowledge and stimula thought as well as widen public understandin That this hope was soundly based is to be see from the discussion which broke out last year ov Dr Oppenheimer's lectures, "Science and th Common Understanding"*. The Reith Lectures we rightly seen as a problem in communication, thoug on a vaster scale than that of the serious lecture o earlier generations. When it was argued that D Oppenheimer's talks had failed to make any re impact on the ordinary listener, the question wa promptly raised whether this was merely an illus ration of the common failure of communication between the physical scientist and the layman to-day, or whether something more was involved

---

* Science and the Common Understanding. By J. Robert Oppenheimer. (The B.B.C. Reith Lectures, 1953.) Pp. vii+127. (London Oxford University Press, 1954.) 10s. 6d. net.

In so far as there was failure of communication, t is clear from the published lectures that the responsibility lies on our system of education as much as on the scientist The lecturer is inevitably limited by the listener's own understanding of science, and failure to grasp Dr Oppenheimer's message is in part n consequence of our neglect to ensure that those eaving our schools to-day have a general understanding of what science is and the part it plays in the world in which they have to live That, incidentally, is a further reminder of the seriousness for the community of the continuing scarcity of science eachers in the schools, quite apart from its effect on the supply of scientists and the technologists them-elves

What emerges, however, from the discussion provoked by these particular Reith Lectures is not imply the importance of a wider public under-tanding of science, or of scientists taking more care n this matter of communication it is the limitations of the specialist as expositor Despite Dr Oppenheimer's intense and wide human sympathies, when he moved outside the sphere of his own special competence he tended to become trite and commonplace Prof. Hill's argument that scientists for the most part are quite ordinary folk outside their own pecial field was well illustrated. The task of xposition, in fact, demands not simply knowledge but also special gifts of a high order that are not ommonly found To discover such expositors and o give them full opportunity is of vital importance o the community to-day. This is not simply a matter of giving the expositor his due status, though hat could be one factor in encouraging the development of such gifts The linking of exposition and authority is perhaps one of the most important unctions of such a series of lectures as the Reith Lectures, and it is one to which universities could well give more thought in arranging their extramural lectures and in encouraging the production of uch works as Sir Walter Moberly suggested Nor is it matter for the universities alone professional nstitutions have their own responsibilities in promoting public understanding of the issues involved n the impact upon public affairs of the technologies with which such institutions may be concerned

The questions of professional discipline involved in he issue of exposition and authority, such as erminology or the relations between one discipline n technology and another, are only one facet of this roblem of communication and public understanding. Exposition and interpretation are conditioned also y the medium of communication involved, and we annot ignore the fact that the use of particular media or changes in political and social conditions may hinder the task of exposition or even make it npossible There are limits to the use of broad-asting, and the potentialities of television are largely nexplored At the same time there is real danger hat they, and particularly television, may be ncouraging an uncritical and unreflective passivity in listener and viewer that may also largely destroy the possibility of influencing them by the printed word

Quite apart from this danger of a new form of illiteracy, effective communication depends not only on the existence of competent expositors and interpreters, but also on the general level of education in the community. Education cannot be dismissed as something concerned solely with fitting the school-leaver for some particular occupation or vocation it is concerned first and foremost with enabling him to live wisely and intelligently in this age of science and technology. For that reason alone, the scientist or technologist has a special concern, as an ordinary citizen, with the standard of general education

There is a further reason why the scientist and technologist are specially concerned with this question of communication—with the problem of interpreting clearly and effectively to the whole community the implications of scientific progress for public policy. Unless there is public understanding as to what science is doing, and the conditions of scientific and technological advance, there is real danger both that adequate financial support will not be forthcoming and policies may be pursued which threaten particular fields of scientific endeavour, possibly of vital import for the public welfare, and the conduct of scientific or other creative activity. It is increasingly important for the specialist to take care over his terminology and bear in mind the needs, not only of his fellow specialists, but also of those other scientists and technologists with whom he may be called upon to co-operate, and he should also consider the problem of interpretation to the general community. Serious thought and a determined effort are required from scientist and layman alike to solve this problem of interpreting to the ordinary citizen what science is doing, the conditions essential for effective scientific work, and the relevance to national welfare of the work and results which to-day in increasing measure are supported by public funds

---

PREHISTORY OF AFRICA

The Prehistoric Cultures of the Horn of Africa

An Analysis of the Stone Age Cultural and Climatic Succession in the Somalilands and Eastern Parts of Abyssinia By Dr J D Clark (Occasional Publications of the Cambridge University Museum of Archæology and Ethnology—Vol 2.) Pp xx+386+52 plates (Cambridge At the University Press, 1954) 105*s* net

DR DESMOND CLARK, curator of the Museum at Livingstone, North Rhodesia, is already well known for his fine work on the banks of the Zambezi near the Victoria Falls and other sites in Northern Rhodesia He was good enough to welcome me there in 1948

In a series of short articles he has already revealed to us some discoveries he had made during his military service in Somaliland and Ethiopia during the Second World War His sojourn there was prolonged during another two and a half years (1941–46) and he has returned there since to complete certain researches

The author has used this work as a thesis for a doctorate at Cambridge He has studied more thoroughly than any other prehistorian this eastern horn of Africa, extending 2,500 miles both in length and breadth

After the usual and most useful physical, geographical and climatic descriptions of this immense region which shared in the violent tectonic phenomena forming the 'rifts' which upset the whole surface of East Africa, the author gives an account of the explorers preceding him Bourg de Bozas (1901), the Italians, Stefani, Paoli and Puccioni (1913–36), Cipriani (1927–32), Graziosi and Puccioni, and others, not forgetting the earlier ones, Seton Karr, Paulitschke and Winkenberg (1880–97) Dr Clark was also familiar with the work of Teilhard de Chardin, Paul Wernert and myself in 1933, both in the region around Obock (French Somaliland) and near Diré Dawa

Near Obock, Father Teilhard and I made the only study attempted so far of the 60- and 30-metre raised beaches of Somaliland. The author describes this in detail, but appears to me to exaggerate when he says the oldest industry is as late as what he calls Acheuleo-Levalloisian Personally, I think it far older, and likewise in the neighbourhood of Diré Dawa He does not mention a bi-faced tool which I think probably Abbevillian, which I picked up at Warka (Harrar), it is true that it was not in its original position, but I think it would be well worth while to search for its original site

Speaking of the extraordinary and abundant industry consisting of picks, found by Paul Wernert at the end of the Gulf of Tadjoura and near Lake Assal, which has not been found in any other place, the author does no more than mention it

Three very crowded chapters of 109 pages follow, on the Quaternary geology and stratigraphy of British Somaliland, the Danakil Rift and the north and east coasts Dr Clark devotes some pages to the problems of the successive sea-levels in the straits and discusses the possibility of an Arabo-Somali continental land-bridge. These pages contain a wealth of most valuable observations and information, a résumé of which is impossible, but their content is indispensable for any future explorer of these regions

After a very short chapter on prehistoric terminology, the author passes in review the different groups of industries represented, according to him, in the regions mentioned, first, Acheuleo-Levalloisian, then Levalloisian, the Stillbay cultures of Somaliland and the industries derived from the Magosian, Magosio-Doian, Hargeisan, then the Somaliland Wilton culture with the Neolithic and Strandlooper influence Every industry *in situ* (and there are a great many sites, some not very important) has its stratigraphy described, enabling the author to correlate them with the sequence of regional climatic conditions, and he gives a precise analysis of the types of chipping and weapons produced, which is quite satisfactory, though no doubt some of the attributions might be disputed It seems to me most improbable that nothing can be classified as older than Acheuleo-Levalloisian

A wealth of sufficiently good illustrations, banished to the end of the volume, enables one to identify the types described and may also suggest that this Old Palæolithic is rather too simplified. It is curious to note how it is concentrated around Obock and the region of British Somaliland Then comes the true Levallois, a long and monotonous stage, rightly related to the North African and Palestinian Levalloiso-Mousterian.

The Stillbay culture (Moustero-Solutrean) follows and is derived from the Levalloisian, as in all southern and tropical Africa Its chief characteristic is flaking, in which pointed triangular flakes predominate, or blades, the latter sometimes blunt-backed burins Stillbay is derived chromatically from Magosian, in which microlithic forms appear, giving place to several variations, one, the Doian, i markedly microlithic and had already been noted to Graziozi, who called it Eibian As for the Hargeisan facies distinguished by an abundance of blades and burins, always few in number in the other facies, the author attributes this to an influence coming from the north, which seems plausible The Doian industry is massed, rather curiously from a geographical point of view, between the two rivers Tana and Yuba Besides microliths, bi-faced arrow-heads with a concave base are found in it, and other types familiar in the Somaliland Wilton facies

Very few pages are devoted to the painted and engraved rocks (there are not many), which, nea Harrar, I had studied, in the Porcupine Cave a Dire Dawa and at Genda Biftou (Sourré) The autho adds some information on Lago Oda, where Wilton is found I am not as certain as he is that the schemati designs in the Porcupine Cave are not earlier than the semi-naturalistic ones at the other two sites I is, however, true that another stylized series seems to follow them, as the author remarks, but there i one point which must be noted, when attempting to judge the age of all these paintings: it is, that superposed on oxen with great horns of the type of those in Genda Biftou, at Lago Oda and other sites, there are splendid fat-tailed sheep. The date of their introduction into the country could, I think, easily be obtained, though this can wait so that there could be more evidence and certainty

My suggestion that it would be well to compar the animals painted with those of ancient Egypt, a well as the way the cows' udders were represented of which I had made a study, led me, though with a certain reserve, to consider they were related Th author seems rather favourable to this idea, though he appears to be astray in his date (the dawn of th Christian era), which seems to me excessively short

In the last pages of the book, Dr Clark attempt to establish a correlation between the industries and climatic phases and to compare the results obtaine with those in other regions in Africa and souther Arabia In short, this book is conscientious, instruc tive and will be extremely useful to future explorer of the country. H BREUIL

CONNECTIVE TISSUE

Connective Tissue in Health and Disease

Edited by Dr G Asboe-Hansen Pp 321+1 plate (Copenhagen Ejnar Munksgaard, 1954) 50 kronor 7 50 dollars

"AND, finally, owing to the difficulty of investigation, and a certain amount of wearines produced by unprofitable discussions, the connectiv tissues have recently been somewhat neglected b microscopists" Written by Heinrich Frey durin the latter half of the past century, these words coul have applied equally well to most of the years whic have passed between then and now. Although it wa known during the seventeenth century that parts of the body were fibrous in nature, the name 'connective tissue' was actually proposed by Johan Muller in 1830, and later Kolliker suggested as an alternative term, 'sustentacular tissue' Reichert organized the existing knowledge on this tissue in 1845, and Virchow demonstrated its importance in pathology n his famous work published in 1858 That the sole function of connective tissue in the normal animal was to act as scaffolding was the accepted view at the time of publication of Frey's work. The English translation (1874), in fact, says "Connective substance takes but little part in physiological occurrences of the mature and healthy body".

This view continued to be generally accepted until relatively recent times However, since the time of Virchow and the recognition of a variety of cells in connective tissue, it became obvious that it played an important part in inflammatory processes, and microscopical studies of wound healing demonstrated ts essential role in the formation of scar tissue, but the problem remained—what part does it play in the normal functioning of the body?

Its mechanical function is obvious, the supporting nature of the deep fascia in the preservation of form and contour and the facilitation of muscular attachment and movement are known to every student of anatomy Modern techniques have added substantially to our knowledge of connective tissue The complex cross-striation of collagen fibres is well known and so too are the presence of hyaluronic acid and chondroitin sulphuric acid in the ground substance. The water-binding ability of the ground substance and its role in œdema are also recognized

The ground substance is the link between the blood vessels carrying oxygen and nutriment and the organs and tissues which require them. Its molecular organization appears to be adapted to facilitate the rapid diffusion of such substances. The adventitia of many blood vessels is, in fact, impregnated with phosphatases, suggesting that it may be acting as a broad membrane with selective control of the substances which pass through it—a suggestion which s supported by the presence of phosphatases in the endothelial cells of the capillaries. In 1924, Hojer demonstrated the dependence of the connective tissues upon adequate supplies of vitamin C, this in the following twenty-five years resulted in a series of papers emphasizing the importance of this vitamin n fibre production and the development of scar tissue in wound healing.

More recently, in 1949, Hench and his colleagues showed that the pituitary, acting through the adrenal, by the medium of adrenocorticotrophic hormone exercised control over connective tissue Cortisone, in fact, was found to depress fibre production in inflammatory conditions This work has stimulated further interest n a tissue which was already gathering in importance, and as the full battery of modern techniques becomes turned upon it, may be expected to yield still more of its secrets and to demonstrate still further its fundamental functions in health and disease

In Asboe Hansen's "Connective Tissue" we have a series of chapters by experts which deal with a wide variety of aspects of the subject. They are, as the editor says, pioneers of modern connective tissue research and their contributions are worth reading from this point of view alone The subjects covered range from morphology and chemistry of the collagen fibres and the ground substance, through the effects of hormones, disease and ageing upon connective tissue in general, to a consideration of its relation to collagen diseases, arthritis, arteriosclerosis, ophthalmology, and cancer. There are many gaps, for example, there is no proper consideration of the elastic fibres although they are referred to in a more or less desultory fashion in some of the chapters. The effects of cortisone and of vitamin C deficiency also receive a cursory treatment. There is no doubt that everyone who has an interest in connective tissue must read this book, but it must be appreciated that it is not a comprehensive work, and the individual chapters do not deal exhaustively with the subjects they discuss The book is, in fact, fundamentally a collection of essays on selected topics related to connective tissue. Its value, however, is greatly reduced by the unforgivable lack of an index

G. H. BOURNE

GEOLOGICAL HISTORY OF CALIFORNIA

Earth Song

A Prologue to History. By Charles L. Camp Pp. xi+127 (Berkeley and Los Angeles University of California Press, London Cambridge University Press, 1952.) 37*s*. 6*d*. net

THE title of this book gives at the first glance little indication of its merit or, indeed, of its scope, and only those who know the author or his other works will realize the import of the song. This is, in fact, a geological history of the State of California with a general account of the life and the reconstructed appearance of some of its former inhabitants during some five hundred million years

It may therefore be thought that it is just another American palæontological book. In some ways it is, with all the wealth of illustration and of interest that such books present But California has a separate history, and at least one of its geological deposits, that of Rancho la Brea with its asphalt trap, is unique. Dr. Camp gives an account of the Californian rocks and deals, period by period, with the life of the early sea, the conquest of the land, and the rise of amphibians and reptiles, leading to the ampler record of the mammals. The whole is embellished by a fine series of pencil drawings by William Gordon Huff, and these are worthy of inspection for their intrinsic interest as well as for the fact that new and authoritative reconstructions of vertebrate fossils always have a great appeal The book also deals with the rise of man in a general way, since there is a regrettable deficiency of fossil men in this Golden State, but goes on to the description of the early Red men and the Folsom implements. There are excellent maps and charts from the pen of Owen J Poe and a number of the charts deal with the chronology Some of these are of considerable value, since the correlation of the delightful-sounding Californian formational and later chronological names with European counterparts or quasi-equivalents is difficult The book contains a glossary, a very useful list of references, and an index There are introductory passages to the chapters in a rather poetic American style, but on the whole the text is excellent and informative and the book should certainly find a place in major reference and university libraries.

W. E. SWINTON

INSTABILITY OF THE EARTH'S AXIS OF ROTATION

By T. GOLD

Royal Greenwich Observatory, Herstmonceux Castle, Sussex

THE axis of rotation of the earth undergoes certain changes of direction, some of which are the results of known causes, whereas others are not yet understood. The major movement is the precession, whereby the axis of the geoidal figure of the earth together with the vector of the angular velocity and that of the angular momentum sweep out a cone of 23° once in twenty-six thousand years. One effect of this is that the year as defined by the seasons is different by one part in twenty-six thousand from the year as defined by the earth's position on its orbit. The precession is due to the motion of the spinning earth under the action of an external couple, namely the gravitational couple exerted by the sun and the moon upon the non-spherical earth. That couple depends on the relative position of these objects and is therefore not steady in time. The result is a superimposed wobble in the direction of the axis of rotation, and it has been given the name of 'nutation'.

There exist, however, other effects not produced by external couples but by a redistribution of matter or angular momentum on or within the earth. They are movements whereby the direction of the axis of rotation remains nearly fixed in space, while the earth itself moves relative to it. The absolute angle by which the axis of rotation moves is some three or four hundred times smaller than the movement of the earth, and it is therefore only the latter which is a measurable effect, usually noted as a variation in the apparent latitude of observation points on the surface of the earth. The angle involved is small, of the order of $\frac{1}{4}''$, the motion is complicated and irregular, but two components can be recognized, one of a period of one year and one of a period of fourteen months.

These movements of the earth relative to its axis are of great significance to theoretical work on geophysics. While the other motions are accurately described by the rigid-body dynamics of the system, this one has its origin, period and damping related to physical conditions on or in the earth. The annual term is thought to have its origin in atmospheric effects[1,2]. The origin of the excitation of the fourteen monthly motion is unknown, but it is understood that the period is the one corresponding to the 'free' or 'Eulerian' nutation. That period is given for a rigid body by $\left(\frac{A}{C-A}\right)T$, where A, A, C are the principal moments of inertia and T is the rotation period. This value would be 305 days for the earth, but a very modest amount of elastic deformation would lengthen it to the observed 420 days. The mean Young's modulus of the earth has to be of the same order as that of steel for the period to suffer as little lengthening due to the deformation[1].

The question of the excitation and the damping of the motion is more difficult to treat. There is no clear-cut way of distinguishing the component of the motion which corresponds to the unknown excitation from that which corresponds to the decay due to internal damping. It can, however, be inferred, o the assumption that the excitation possesses no consistency, that the damping time must be fairly shor and cannot be more than a few periods, ten at th most, for a decay to $1/e$ of the original amplitude i the absence of further excitation. Alone the actua amplitude of the motion, together with an estimat of the excitation taken from just those occasion when the amplitude suffered an increase, puts a limi of this order on the damping time; with lesse damping the amplitude would be expected to b greater according to the statistical addition o exciting impulses. (Jeffreys quotes an estimate o fifteen years; Walker and Young, recently, one o three years[3].)

Where does this high damping arise? The requirement is for some relative motion to occur in whic energy can be dissipated. But the obvious places o the surface, such as the atmosphere and the oceans cannot be responsible, for the material that move relative to the solid part of the earth requires to hav more than a certain moment of inertia in order to b able to cause the damping at all; and it then require to be coupled in a suitably dissipative way to th solid part of the earth. The moment of inertia o the atmosphere and oceans is insufficient. The liqui core of the earth has been discussed as a possibl source of the damping, but its small moment of inerti (10 or 12 per cent of the whole) can be shown to rul it out, too[4].

The large damping must then arise from a dissipative deformation of the solid part of the earth. The existence of a high Young's modulus is no guide to the plastic flow that may occur in the material, or to the relation between the flow and the stress. It is difficult to see in what other way this lack of permanent stiffness could be measured. The damping of earthquakes is scarcely relevant, as it is concerned with periods 10^8 times shorter. The solid-body tides of the earth are concerned with a period a thousand times shorter than the nutation, and even there the presence of a small amount of dissipation would escape detection.

The existence of gravity anomalies over large regions is sometimes taken as an indication of long-term stiffness down to a depth of at least a few hundred kilometres. Such gravity anomalies are related to long-lived tectonic features and are therefore quite reasonably inferred to be long-lived themselves. But on the other hand, the bulk of the materials on the surface of the earth—the continents, the mountains—are not supported by substantial non-hydrostatic forces from depths below a hundred kilometres. If the occurrence of permanent stiffness down to great depths much below a hundred kilometres were a world-wide phenomenon, then it would be a matter for surprise to find that all the major deformations of the crust that have occurred have managed only so rarely to pile material up on an underlying stiff base to produce a very large gravity anomaly. The information obtained from gravity surveys therefore suggests that, except for a few areas, there is no appreciable permanent stiffness below about a hundred kilometres. Stiffness in some localities is, of course, not decisive for the behaviour of the wobbling earth.

Another line of argument also suggests the absence of permanent stiffness of the main geoidal shape of the earth. At present the solid part of the earth is very nearly the equilibrium shape appropriate to the present speed of rotation. Any severe departure either way from this shape would show itself very simply: the oceans which take up the equilibrium shape instantly would then dominate either at the poles or in equatorial regions. In fact, the distribution of land and water shows no significant tendency of such a type. On the other hand, the earth's speed of rotation is believed to have changed significantly n geological time. It has been changed either by giving up angular momentum to the moon through the agency of tidal friction—and the moon shows signs of a tidal bulge appropriate to a greater proxmity to the earth—or the speed of rotation may be determined by the resonance with atmospheric tides, n which case it must have changed substantially with changes in the structure of the atmosphere[5].

There exist many forms of non-elastic behaviour of solids other than plastic flow, and all of them lead o dissipation of energy in a stress cycle. “Elastic after working”, for example, has been mentioned by Jeffreys in this context[1]. Plastic flow is, however, the simplest type of behaviour, and it occurs in most solids in the vicinity of the melting point. It is a behaviour in which there is no ‘memory’ in he material, the instantaneous stress defining the nstantaneous elastic strain and the instantaneous ate of flow. There seems to be no case for invoking any of the more complicated types of behaviour in which the material possesses a ‘memory’ determining ts reaction to a stress, such as is often the case with materials composed of large and complicated molecules. Also plastic flow must in any event be invoked o account for the absence of long-term rigidity which has been inferred from other considerations.

The speed of plastic flow can now be deduced on the basis of the assumption that the damping of the ree nutation arises entirely from this cause, and that he characteristic time is ten periods. If there were an angular separation between the axis of figure and he axis of rotation, then the plastic flow would be uch as to allow the figure to become deformed and ence its axis of symmetry to move. In the absence f other effects, the axis of symmetry would then pproach the axis of rotation by ten per cent of their ngular separation in each period of fourteen months. or the motion of nutation itself this plasticity would esult in dissipation only, but other motions with ow secular effects are made possible.

The long-term stability of the axis must then be onsidered. A spinning sphere would possess no tability of its axis of rotation at all, the smallest eetle walking over it would be able to change the xis of rotation relative to markings on the sphere y an arbitrarily large angle, the axis of rotation in pace would change by a small angle only. What tability the earth's axis possesses against movement elative to the solid earth is derived from the geoidal hape, implying that it is spinning around the rincipal axis of inertia of greatest moment and ence possessing less kinetic energy than if it spun ith the same angular momentum around any other xis. This complete stability against a secular change therefore dependent upon the stability of the hape. If, as a result of a slight redistribution of mass, the instantaneous axis of rotation were to be moved by a small angle (such as is the case in the free nutation) then, if there is plastic flow, the axis of figure would slowly follow. For example, let us consider a redistribution of mass the dynamical effects of which are the same as those of an excess mass situated somewhere neither at the equator nor at the pole. The damping will assure that the initial wobble is stabilized to a spin around the new principal axis. But so long as there exists the excess mass at one place, the axis of the geoidal shape cannot be also a principal axis. Therefore, as the geoidal shape alters so as to become adjusted to the new axis of rotation, so the axis of rotation moves on. The magnitude and the angle of latitude of the excess mass define, in fact, not simply an angle of displacement of the earth's axis relative to the solid surface; they define an angle between the instantaneous axis of rotation and the axis of the geoid. The magnitude of this angle in turn defines the stress and hence the rate of flow altering the shape, given by the constants of plasticity of the earth. The resulting rate of flow gives the rate at which the axis of the geoid moves relative to markings on the earth, and that is now also the rate at which the rotational axis moves relative to the earth, though, of course, remaining nearly fixed in space. It is as with the ass and the carrot hanging from a stick held by the rider, to be more precise, as if the ass would run faster the farther the carrot was held in front of his nose. But how far can the ass be made to run by this method?

In the movement of the earth the latitude and the excess mass were decisive. The angle between the two axes and therefore the rate of polar wander will be greatest for an excess mass at a latitude of 45°, and there will be no position reached in the motion where the angle vanishes until the axes have swung around so as to make the new equator go through the position of the excess mass. The angle α between the axis of figure and the axis of rotation is proportional to $M \sin\theta \cos\theta$, where M is the excess mass and θ its latitude. The rate of deformation and hence of polar wander must increase with increasing α, but the actual relation between the quantities depends upon the details of the non-elastic properties of the material. The rate of plastic flow as well as other departures from elasticity generally increase with increasing stress faster than in proportion to the stress. If, therefore, the long-term effects were connected with the occurrence from time to time of larger angles α than can be seen in the free nutation at present, one would merely be under-estimating the amount of plastic flow if one assumed the rate to be proportional to α and given by the damping of the free nutation. The distance to which the wander will proceed is independent of M; it is simply the angle θ. One has here the situation of a secular instability where a small disturbance does not produce a small effect but where it produces a large effect slowly.

Sir George Darwin considered a motion of that sort[6] and described it qualitatively, but in summing up he considered it unlikely that the motion had, in fact, been taking place, for he would have expected it to have resulted in a change of the distribution of land and water. Geologists, however, had assured him of the permanence of the oceans. Due to the new knowledge of isostasy, this argument has by now lost all force. In the case of perfect isostasy, an ocean basin would be characterized by the occurrence of a region of greater average density below the ocean floor. The depth of any point of the basin below a certain equipotential surface such as the sea-level would be given solely by the local distribution of density, and would therefore be unaffected by a change of the geoidal shape to a new axis. The actual isostatic compensation is not perfect; but still it is known that there is a considerable degree of correspondence between the heights of the surface and the densities below it. In so far as that is true, the distribution of oceans and continents would remain unaffected by polar wander. The details of the nutation were also not available to Darwin, and the case for plastic flow was therefore weaker and lacking a quantitative estimate.

The dynamics of the problem do not introduce any long time constants, and the speed of polar wander must be entirely dictated by the rate of plastic flow. With the plasticity derived from the damping of the free nutation, we can make an estimate of the speeds involved; for the rate of movement of the axis of figure would have to be one-tenth of the angle α, or more, per annum. If a continent of the size of South America were suddenly raised by 30 metres, an angle of separation of the two axes of the order of one-hundredth of a degree would result. The plastic flow would then amount to a movement of one-thousandth of a degree per annum. The earth would hence topple over at a rate of one degree per thousand years or by a large angle in about 10^5 years. The order of magnitude of the speed of this process would therefore be preserved if the raising of a continent by 30 metres occurred not suddenly but in a time of the order of 10^5 years. This rate is perhaps higher than could be expected. A continent of that size does not rise perhaps at such a rate; and the observed degree of isostasy on the earth suggests that the rise of a mass is associated with such a redistribution of material that the actual increase of moment (in the sense of the excess mass discussed before) is very much less than corresponds to the elevation of the surface. As in this discussion the rate of tipping is proportional to the square root of the rate of elevation of mass, the estimate will not be as rough as the geological data must necessarily be. A rate of elevation of the continent by three metres in 10^6 years is certainly a low figure and would result in a time of 10^6 years for a large-angle change in the orientation of the earth relative to its axis of rotation.

This, then, is the possible effect using the plasticity suggested by the nutation. But what motion must we then expect in geological times, when there are constantly variations in the distribution of masses? It is perhaps easiest to consider this with the aid of a model of the earth which, though it may be false in other respects, possesses just the bare features required for these dynamical processes. That model would consist of a plastic spheroid representing all the earth below a hundred kilometres depth, of such plasticity that no forces of hydrostatic disequilibrium can be upheld there. On it there is floating a crust consisting of a close mosaic of pieces of different densities. This model would possess different values of the moments of inertia about different axes of rotation. Though in each case the interior will become the appropriate spheroid, the non-uniform crust will be in a different relation to it; and the blocks of the crust made of lighter materials will make a greater contribution to the moment of inertia at each latitude than the heavier ones, as they represent the same quantity of material, but at a greater distance from the axis. The secular instability that we have discussed is such as to rotate this body relative to the axis of rotation until its spin is around the axis of the greatest possible moment of inertia. Movements of material on the surface of the earth correspond to changes in the masses and mean densities of the blocks. It wil therefore occur from time to time that a new distribution arises that would produce a greater moment of inertia for the body if it spun around another axis. Whether this situation must now be expected to produce a secular motion whereby the axis is continuously hunting the direction of the greatest possible moment of inertia is not immediately clear; for the movement of the axis in turn causes certain redistributions of masses of air and water, and those may be in such a sense as to help or to hinder the movement. Possibly the most important effect of that sort is circumpolar glaciation producing large and rapid variations of mass at latitudes not so far from 45°, where the dynamical effect would be a maximum, and altering the sea-level everywhere also in intermediate latitudes. In considering the small present-day movements of the axis, Munk and Revelle[7] came to a similar conclusion and stated that the pole should be expected to move towards the location at which most ice is melting at present.

It may be, then, that instead of a passive stability of the pole due to stiffness of the shape of the earth there is merely from time to time a stability arising from a feed-back process that balances out sligh asymmetries that arise. If indeed glaciation is the dominant effect then, for example, the pole situated in a circular ocean extending over some 20° o latitude would tend to be in a stable position. Any departure of the pole from the centre of that ocean would cause glaciation on the land towards which i had moved (the ice floating on the water has n significant dynamical consequence), and such an addition of mass in that locality would act in the sense of pushing the pole away from that land. From the work of Jeffreys[1], Mintz and Munk[2] and others it is clear that atmospheric effects may also contribute to such mechanisms.

The movements of the pole relative to the surface of the earth that have been measured in the past fifty years do not amount to much. If an estimate is mad of the centre of the curves of travel of the North pole during the nutations, then it appears that thi centre may have been drifting by something of th order of 0.1″ in the direction of Newfoundland in th past fifty years (corresponding reasonably well to th continued melting of Greenland ice)[7–9]. Such a rat of movement, even if it continued in the sam direction, would thus take about 2 × 10^8 years t turn the earth over by 90°. There is also othe evidence in past geological epochs for long intervals of the order of fifty million years, of no drasti climatic change. On the other hand, there is ampl evidence that drastic changes of climate have occurre occasionally in geological time, and such change have served geologists for the division of time int geological epochs. It is thus tempting to sugges that there have been just a few occasions when th axis has been 'free' and has swung around as rapidl as would be given by the stiffness of the earth an the rates of tectonic movement, leading to a time scale of the order of 10^5 or 10^6 years, but scarcel longer. But then in its rapid movement it ha encountered a trap where it was caught within small angle by the shifts in masses which its move ment itself induced. It must then have remaine in that neighbourhood until either there was a sufficient tectonic change to lead to an unbalance greater than could be compensated by glaciation or atmospheric effects, or until the distribution of land and water had been so modified as to destroy the mechanism of the trap. There would then have followed another period of hunting until a new trap became operative The recent observations of fossil magnetism of rocks and sediments show such great promise that we can expect before long to have a good indication of the movements of the pole that have, in fact, occurred in geological history It is known already that a movement of at least some regions relative to the position of the pole is indicated by the results, and this constitutes a further item of observation along with such geological items as the glaciation of now tropical zones, that force geophysicists to consider that either continental drift or polar movement must have occurred on a substantial scale. In due course the magnetic data will make the distinction between the two The occurrence of continental drift over great distances would imply new and surprising data about the construction of the earth and in particular its crust, while the occurrence of wandering of the poles over great distances would fit in well with all that is known about the earth, and would reaffirm what can already be inferred from other data.

Jeffreys, H, "The Earth" (Camb Univ Press, 3rd edit 1952)

Mintz, Y, and Munk, W, *Mon Not Roy Astro Soc, Geophys Supp*, **6**, No 9 (1954)

Walker, A M, and Young, A, *Mon Not Roy Astro Soc* (in the press)

Bondi, H, and Gold, T, *Mon Not Roy Astro Soc* (in the press)

Holmberg, E R R, *Mon Not Roy Astro Soc, Geophys Supp*, **6**, No 6 (1952)

Darwin, G H, *Phil Trans Roy Soc*, Pt 1, **167** (1877)

Munk, W, and Revelle, R, *Amer J Sci*, **250** (1952)

Munk, W, and Revelle, R, *Mon Not Roy Astro Soc, Geophys Supp*, **6**, No 6 (1952)

Melchoir, P J, *Obs Roy Belgique*, Mon 3 (1954)

SCIENTIFIC INTELLIGENCE AND DEFENCE

By CHAPMAN PINCHER

SCIENTISTS in Britain are to play a much bigger part in Intelligence work as a result of recent changes effected by the Defence Ministry *Ad hoc* panels of scientists and technologists expert on particular matters are to be set up to help in the nterpretation and collation of certain kinds of nformation collected through Intelligence sources

These scientists will be drawn from the universities and from industry as well as from Government stablishments After security clearance they will be asked to assist in the analysis of information about oreign weapons, equipments and defence potentialities

Since the War, responsibility for this type of work has rested nominally with the rather small Directorate of Scientific Intelligence in the Defence Ministry That arrangement has proved to be impracticable The Fighting Services have become so technical that it is no longer possible to draw a line between the outine Intelligence work for which they should be held responsible and scientific Intelligence In fact, ntelligence chiefs have despaired of defining scientific ntelligence except in the general terms that it is the knowledge and appraisal by scientific methods of oreign developments in science and technology

The Directorate of Scientific Intelligence has therefore ceased to exist as a separate unit. It has been absorbed into the Joint Intelligence Bureau, which, though still retaining its name, has been given much wider functions

The Joint Intelligence Bureau will henceforth serve as a central Intelligence agency to which a wide range of strategic Intelligence information will be transmitted Its staff will be responsible for ensuring that the utmost possible use is made of such information.

This change brings the British system more closely into line with the Intelligence methods adopted by the United States Government after the War. The failure to appreciate the imminence of the Japanese attack on the American Fleet at Pearl Harbour was later attributed to defects in the higher levels of the Intelligence system. Information clearly pointing to the attack and its approximate date was available in the various separate Intelligence agencies, but because there was no central authority it had never been properly 'appreciated' and had not been put forward at the levels where decisions are made. The U S Central Intelligence Agency, now headed by Mr Allen Dulles, brother of Secretary of State John Foster Dulles, was therefore set up to ensure proper utilization of Intelligence information in the future. Its necessity has been enhanced by the growing danger of the possibly decisive influence in future wars of 'Atomic Pearl Harbours' All Intelligence information from the Fighting Services, the Secret Service and the Atomic Energy Commission is now canalized to the U S Central Intelligence Agency.

The British reorganization has left the Fighting Services responsible for their own operational Intelligence work—an arrangement which is thought to be more flexible as it leaves the Services less isolated from the central agency. It is believed that the people who interpret scientific Intelligence will be more effective if they retain closer connexion with the Service in which they themselves are most expert

Major-General Sir Kenneth Strong, former chief of the Joint Intelligence Bureau, remains head of the enlarged organization Mr H S. Young, who has been acting director of scientific Intelligence since the resignation of Prof R. V Jones from that post last year, has been appointed a deputy director of the Joint Intelligence Bureau

After collation by the Bureau, matters of importance will be put forward to the Joint Intelligence Committee, a high-level group which includes the heads of all the Intelligence agencies and a Foreign Office representative. This committee will produce a 'considered view' on the matters in hand and make it available to Service commanders, ministers, senior Civil servants, ambassadors and others who need it

The enlarged Joint Intelligence Bureau is responsible to the Defence Minister, Mr Harold Macmillan, who has a direct voice in the Cabinet. As an additional link with the Joint Intelligence Committee and the Intelligence chiefs, a post of Scientific Adviser on Intelligence to the Defence Minister has been created as part of the new arrangements Mr E C Williams, formerly director of operational research in the Admiralty, has been appointed to it

Though these changes have been made entirely on the basis of British experience, it is believed they will cause satisfaction in Washington—an important consideration, as fears about British security have held up interchange of information on atomic weapons and other defence developments.

OBITUARIES

Sir Edward Mellanby, G.B.E., K.C.B., F.R.S.

STATESMAN for a quarter of a century, scientist for half a century one feels in preparing this notice as Mellanby himself said he felt when faced with the preparation of the Hopkins Memorial Lecture, that the task requires a "degree of knowledge, skill, judgement and sympathy . almost unattainable"[1].

Sir Edward left the stamp of his skill as a statesman on the work of the Medical Research Council, of which he was secretary for sixteen years The present members of the Medical Research Council have in the following words recorded "their high appreciation of his great services to medical science As Secretary of the Council from 1933 to 1949, after being a Member since 1931, Sir Edward Mellanby took the leading part in the difficult tasks of deploying the Council's scientific resources in support of the national effort during the second world war and of reconstructing and notably expanding the organisation thereafter. To these responsibilities he brought an intense regard for scientific truth, a wide knowledge and deep understanding of medical problems, a sure sense of what was important in research, and a constant desire to encourage all who showed ability as investigators and ideas likely to lead to real discovery His endeavours had great success"[2].

It has been said that he was in some ways "not well cast as an administrator"[3], but he brought to this highly responsible post the qualities of a statesman—sagacity, far-sightedness and skill in the management of practical affairs—in unusual measure, he deputed to the professional administrator those matters which could safely be entrusted to him. It was characteristic that on one occasion he denied that the Council had a policy in financing research workers except "to find the right men and back them in every way possible"[4]. He often said that the recruitment of first-class administrators was an easy matter compared with securing men of the best type for medical research, such men are, he said, "limited in number, and cannot be appreciably increased by any known method They must in general be what is known as clever men, but cleverness alone accounts for little. In addition, they must be men of strong character, capable of hard and often disheartening work, with power to distinguish truth from falsehood, prepared to spend their lives with limited social contacts and to forego riches" Such men, he recognized, are rare, and he considered that one aspect of the Council's work was, short of this ideal, "to attract able men, and by providing financial assistance and ensuring the proper kind of training, helping them to a career of medical research"[5] While he stoutly maintained that the supply of the right type of man was the basis of success in medical research, he defined the main function of the Medical Research Council as the promotion of "scientific investigations for the acquisition of knowledge likely to be of value for the prevention, diagnosis, and treatment of disease, and for the maintenance of normal health and full human efficiency"[6]

On the many occasions when he gave important named lectures he drove home with telling examples the benefits to mankind in the past hundred years of the application of the discoveries in medical science It is fifteen years ago since he opened his Rede Lecture with the words "Probably at no time in the world's history has the average citizen of this and most other civilized communities felt so insecure against death by violence At no time in the world's history has the same citizen had reason to feel so secure against death by disease" Concluding this Lecture, he claimed that "medical science and its instrument, medical research, have indeed justified themselves For every problem—social and economic . the only solution is more knowledge and more wisdom to use this knowledge There is no limit to the amount of knowledge to be gained, if the medical scientist is given the opportunities and facilities for his work. Would that the same could be said about the wisdom necessary to make the best use of this knowledge !"[7].

One principle that he returned to time and again was the difference in effectiveness in research of the experimental method over observation "Where", he said, quoting Lord Moulton, "we are reduced to observation, science crawls Where and in proportion as you can use experiment, science advances rapidly"[5] He recognized, however, "the enormous difficulties of the experimental method in biological investigation due to the complexity of the inter-acting materials"[8] "Long experience has taught me", he said in his Harveian Oration, "that it is seldom in the facts of discovery, but rather in the interpretation, especially the first interpretation, that mistakes are made"[4].

In his personal work, Mellanby considered himself fortunate to have come as a medical student in 1902 in the scientific care of Hopkins, in whose laboratory he later spent two years (1905–7) as a research worker. Mellanby published his first paper in the *Journal of Physiology* in 1908 on creatine and creatinine Even at this time he had begun to pry into the effects of disease, in this case liver damage carcinoma and other conditions likely to affect creatine metabolism, and his broad biological interest was also already manifest in that he examined the creatine content of various animals and its occurrence in the course of development of several of these in an attempt to discover whether from ontogeny and phylogeny light might be cast on the evolution o vertebrate animals An incidental observation in th course of this work—that creatine is destroyed by bacterial action—led him in later papers to examin the problem of the effects of the bacteria from th alimentary canal on various substances One outcome of this work was the discovery that an organism in the alimentary canal could convert histidine into histamine, a substance now of great biologica importance He continued the study of creatine with reference to the metabolism of lactating women which was the subject of his first communication—presented by Hopkins—to the Royal Society early in 1913. Next he published the results of an attemp to discover the relationship between the formation and absorption of histamine and diarrhœa and vomiting in infants[9]. Thus there was already evidence of his interest in the interaction between clinical and experimental work in the laboratory, th theme of a book published in 1934, "Nutrition and Disease", based on the Croonian Lectures delivered to the Royal College of Physicians in 1933 By 191 he had begun to publish the results of his investigations on the production of experimental rickets This investigation arose out of a plan drawn up by the original Medical Research Committee in 1913 Rickets was included in a list of major disabling diseases besetting Great Britain at that time Mellanby was asked to investigate the part processe of oxidation might play in the etiology of the disease is experiments soon demonstrated that serious bone bnormalities result from faulty diet, and this riented the work towards the hypothesis that the iet might well be a primary factor in the etiology f the disease From that time onwards investigations ecame more and more along dietetic and nutritional nes, as seen in "A Story of Nutritional Research", is Abraham Flexner Lectures published in 1950[10] ne result of this work is that whereas at one time stunted children with bandy legs were so common s either to pass unnoticed or be a source of amusement", nowadays if we saw them "we would be ngry, because we would realise they were the roducts of ignorance or negligence"[8]

It was his involvement in this investigation of ickets that decided Mellanby not to return to Camridge when invited to by Hopkins when the latter ecame, in 1920, the first professor of biochemistry at ambridge It was, he has said, a crucial decision and robably a wrong one, and hereafter he felt he could o longer be regarded as a biochemist By this time he index to his publications had been once through he alphabet, before his death the alphabet was to e exhausted more than twice again

There is space here to deal with only a few of the main themes of Mellanby's research since that time ne was the presence in food of substances having pecific harmful effects, an inquiry which arose out f the work on effects of cereals on bones Evidence vas obtained of the presence in some foods of an nti-calcifying substance, later identified as phytic cid[10]. There was, he demonstrated, antagonism etween phytate and vitamin D, the former trying to xpel calcium from the body, the latter promoting its bsorption and retention. This anti-calcifying factor e included in a group of substances which he called oxamins, now more widely known as anti-metabolites.

Running almost in parallel with the work on the ardening of bones was his study of the shaping and nodelling of bones—work which began with an bservation made in the study of rickets that in itamin A-deficient animals damage to the nerves of he animal occurred, with the development of severe taxia and loss of sensation of various kinds resulting n deafness, blindness and anosmia Mellanby was ltimately able to show that, in his own words, these two inseparables, vitamins A and D, the avid and Jonathan of nutrition, whose faithful lliance in distribution and similarity of many hemical and physical properties has caused so much ouble to hosts of physiologists, biochemists and ther scientists, work in harmony and on the same ructures at the time of their active careers in the nimal body Although their functions are different, ney unite in directing and controlling the building up nd maintenance of bone structure"[10] Despite the owth of knowledge of the effect of vitamin A on the ody to which he had largely contributed, Mellanby ontinued to be dissatisfied because so little was nown about the site and the mechanism of its action e determined to examine the direct effect of the itamin on the tissue by tissue-culture techniques, nd after preliminary exploration of the problem he ought the collaboration of Dr Honor Fell They ound among a number of other interesting results ne exciting effect on tissues of plasma with a high itamin A content, namely, that chick ectoderm evelops not into normal skin, but into more highly eveloped mucus-secreting ciliated respiratory pithelium Returned to normal plasma, such tissue everts to normal skin Likewise in culture in high vitamin A plasma, corneal epithelium becomes hyperplastic, like the conjunctiva Clearly, since metaplasia is most prominently seen in cancer, this discovery has a bearing on this outstanding unsolved medical problem. He also thought that a similar type of approach may well be rewarded in the study of other unsolved problems of disease involving degenerative and other structural changes due to altered metabolism

Another recent discovery, and again an extension of earlier research, is the experimental proof that agenized flour is toxic to dogs and other animals The substance formed by the action of agene (nitrogen trichloride) on a wheat protein has been identified as methionine sulphoximine The mechanism of the biological action of this substance is still unknown. This discovery has had far-reaching effects in emphasizing the need for attention to be given to the effects of the chemical manipulation of food Recently steps have been taken to secure international action in this field. Commenting in his Sanderson-Wells Lecture on the increased incidence in the past fifty years of certain morbid conditions, Mellanby said that he found it "difficult to avoid the conclusion that some at least of these increases in disease are due to errors in living recently introduced or greatly expanded in modern times", and that the effects of chemical manipulation of foods provide "at least a subject worthy of enquiry" and one which "might well be considered whenever a disease commonly found in countries which use these methods has resisted all efforts of the investigator to find a satisfactory ætiological basis"[11]

These examples by no means exhaust the topics of Mellanby's published researches, which also include studies on alcoholism and disease of the thyroid gland, ergotism, the metabolism and transmission of cancer, the control of infections, especially puerperal sepsis and maternal mortality Nor does it include new probings into some major problems in disease which were in hand at the time of his death His declared aim was to open up new fields of research, especially of a physiological nature. This was a deliberate attempt to secure relatively more attention for biological objectives in research He restricted his own interests in the biochemical and chemical aspects of problems he was studying, as he felt that biochemistry was developing rapidly into a special branch of chemistry only too rarely with any direct relation to biological function

In his book, "Nutrition and Disease"[12], Sir Edward had outlined a plan for combining research in the clinical and laboratory fields, his success in applying his plan on a national scale will, it is hoped, be evident from the foregoing incomplete survey His success is the more remarkable when it is realized that not only was there a substantial volume of peace-time research initiated and sponsored by the Medical Research Council, but also an enormously increased activity on numerous war-time problems in civilian matters and in all branches of the Fighting Services The last two reports of the Medical Research Council published while Sir Edward Mellanby was still its secretary contain admirable accounts of these activities

In nutrition, Mellanby's chosen field of special interest and research, he early achieved international prominence, and in the early 'thirties he was made chairman of the League of Nations International Technical Commission on Nutrition He was an active member of the Accessory Food Factors Committee of the Medical Research Council since its inception and its chairman for many years. He contributed in this and other ways to the improvement of health through better nutrition. As a member of the Scientific Food Policy Committee of the War Cabinet and later of the Chief Medical Officer's Committee of the Ministry of Health, he exercised a powerful influence on the medical aspects of food policy in Great Britain. As chairman of the Food Rationing (Special Diets) Advisory Committee he took an important part in the difficult task of deciding how war-time rations should be modified or supplemented for persons with certain diseases

Research abroad owes much to his influence, and in recent years he visited Africa, India, Australia and New Zealand for the express purpose of advising on research Earlier he had been to Canada and on other occasions to the United States In all these countries he had many friends. He took an active interest in the work of the British Council and was chairman of the advisory Medical Panel from its formation in 1942, and he gave unstinting help and encouragement to the Council's medical work, his interest in the *British Medical Bulletin* never flagged, and it was his abiding concern to ensure that this journal conformed to its main purpose of presenting to overseas readers the many aspects of medical research in which British workers have excelled For many years he was active in the development of medical research in Colonial territories and was chairman of the Colonial Medical Research Committee Not only did he recognize the great need for the application of medical science, but he also foresaw what has only recently been widely recognized as a major problem, namely, the need for relating the rapidly increasing population to the supply of sufficient food He insisted that "most of the political, social and economic difficulties in tropical countries are, and will continue to be, biological in nature, and the sooner this fact is recognized the sooner will these difficulties be controlled or dispersed . . . and we can only pray," he said, "that there is sufficient wisdom left among us to use the fruits of science properly"[7]

Those who have known Sir Edward Mellanby and his work can easily add further tributes from their knowledge of other contributions of this great man to the quantity and quality of the life and living of mankind The illustrations given speak, out of his own mind, of the man, his work, character, ideals and objectives in ways which need no elucidation, indeed, any attempt to do so would be unjustifiable presumption It is a sign of his influence and calibre that those who knew him best are united in their profound respect and affection for him Our appreciation of the contribution of his constant partner, Lady Mellanby, must be one of gratitude, and we trust that she, with us, will find comfort in contemplation of his magnificent record of achievement

B S Platt

Prof. J. K. Parnas

News has been received recently of the death o J K. Parnas, formerly professor of physiologica chemistry in the University of Lwów (Lemberg) known internationally for his fundamental researche in the biochemistry of muscle

Jakób Karol Parnas was born in Eastern Polan on January 17, 1884, and as a boy was educated i Lwów He then entered upon an academic career a a student of chemistry, at the Technische Hochschul of Berlin-Charlottenburg In 1905 he joined th laboratory of Richard Willstatter in Zurich, where a a subject for his Ph D. dissertation he was allotte the tedious task of preparing the so-called third (o 'amphi') naphthoquinone It was much to the pupil' credit, and to his teacher's delight, when two year later, after numerous trials with a wide range o metallic oxides, he succeeded in preparing th crystals of this long-sought-after labile compound Years later this achievement brought him war praise from Willstatter, who in his autobiograph records also the accident which occurred in th course of Parnas's experiments, when a preparatio of gold oxide freshly removed from the desiccato exploded in contact with a spatula, and countles particles of gold became lodged in the young experimenter's eye. Although some of the larger particle were removed surgically, smaller ones stayed in th cornea permanently, fortunately without discomfor to the bearer, who in his later years was ever read to exhibit them to his students and accompany thi with a suitable reference to the physiological inertnes of gold as a 'noble' metal

Having thus obtained his doctorate, Parnas removed to Hofmeister's laboratory in Strassburg where he worked until the outbreak of war in 1914 except for short periods spent on research at th Stazione Zoologica in Naples and in the Physiologica Laboratory in Cambridge The years which he spen with Hofmeister, first as 'assistant' and later a 'dozent', remained in Parnas's memory as his happies ones, and for Hofmeister himself he preserve lasting devotion and admiration His first scientifi contribution from this laboratory, which he submitted to the *Biochemische Zeitschrift* in 1906, wa on the purification, properties and composition c brain cephalin, a subject of which he was very fon but on which he worked only for a few more year

Soon afterwards, Parnas's interest turned to th intermediary metabolism of animal tissues—mor specifically, the physiological significance of th Cannizaro reaction In 1910 he demonstrated tha this reaction, in which two molecules of aldehyd interact to produce one molecule of acid and one c alcohol, is catalysed in the liver by a soluble enzym which he named 'aldehyde mutase' The study c this enzyme formed an introduction to Parnas' further work on enzymic processes underlying th intermediary carbohydrate metabolism of tissue particularly that of muscles Among his other contributions made at Strassburg, three deserve specifi mention (i) the recognition of the fact that of th two optical isomers of lactic acid, one, namely L(+) lactic acid, is metabolized in the animal bod in preference to the D(−) isomer, (ii) the elaboratio of energy requirements for smooth and skeleta muscles, both when resting and during contraction and (iii) a quantitative study—one of the earliest o its kind—of the relationship between the disappearance of glycogen and the formation of lactic acid i isolated, contracting frog muscles In the last

---

[1] Mellanby, E, The Hopkins Memorial Lecture, *J Chem Soc*, 713 (May 1948)

[2] Medical Research Council Minute, February 18, 1955

[3] *Lancet*, p 309 (February 5, 1955)

[4] Mellanby, E, The Harveian Oration, *Lancet*, ii, 929 (1939)

[5] Mellanby, E, The Huxley Lecture, pp 12 and 7 (1935)

[6] Medical Research Council Report 1945–8, p 37

[7] Mellanby, E, Rede Lecture, pp 5, 62 and 59 (Camb Univ Press, 1939)

[8] Mellanby, E, 13th Stephen Paget Memorial Lecture, "The Fight Against Disease", **27**, pp 5, 4, 2 (1939)

[9] Mellanby, E, *Quart J Med*, **9**, No 35 (1916)

[10] Mellanby, E, "A Story of Nutritional Research", pp 430 and 431 (Williams and Hopkins, Baltimore, 1950)

[11] Mellanby, E, *Brit Med J*, ii, 863 (1951)

[12] Mellanby, E, "Nutrition and Disease" (Oliver and Boyd, Edinburgh, 1934)

mentioned study, Parnas carried out his experiments partly in collaboration with Richard Wagner, their two names are also linked with the design, a few years ater, of the Parnas–Wagner distillation apparatus for the micro-determination of nitrogen

After the First World War, Parnas returned to his native country and resumed with great vigour his research activities, at first for a short time in Warsaw, and later at the Joannes-Casimirus University in Lwów, where within a few years he succeeded in creating a flourishing centre of teaching and research and in assembling around him a group of devoted and enthusiastic co-workers, often referred to as the Parnas School' Of these, J Heller (now professor of biochemistry in Warsaw) and W Mozolowski (now occupying the chair of biochemistry in Gdańsk) shared with Parnas the credit for the discovery of the process of ammonia formation in blood (1924) and in muscle (1927), and for establishing that this ammoniogenesis is due to the deamination of adenylic acid to inosinic acid. Further intense research on the significance of this process in muscular contraction was greatly facilitated by the method for large-scale preparation of adenylic acid developed in Parnas's aboratory in 1932 by his pupil and co-worker, Paul Ostern (who died tragically during the Second World War).

The Parnas reaction, discovered in 1934, established that adenosine triphosphate, the mother-substance of adenylic acid, is directly involved in the enzymic transfer of phosphate groups, from the phosphorylated intermediary products of muscle glycogenolysis, to creatine This finding, coupled with the Lohmann reaction, formed the basis of much of the later work on the 'chemical linkage' processes, not only in the muscle but also in all other animal tissues, as well as in yeast and bacteria The 1930's were probably the most active period in Parnas's life. Those who, like myself, had the good fortune to be associated with him in that phase of his activity, will remain filled with admiration for his qualities of leadership, his profound knowledge of chemistry and physiology, his exceptional skill in designing experiments, and last but not least, his almost uncanny encyclopædic memory This great gift enabled Parnas to master several languages, to retain faultlessly the names and faces of countless students, to quote page-long excerpts of Greek and Latin poetry, which he learnt as a boy, and to shower upon his pupils scientific facts and chemical formulæ.

As a teacher, Parnas was most stimulating, and his text-book of biochemistry, written in Polish, is a masterpiece Sometimes, carried away by his enthusiasm while lecturing, in exposing the intricate mechanisms of chemical reactions (which he invariably illustrated by the most complicated and ingenious demonstrations), he would forget completely that but few in his student audience were capable of following him A man of exceptionally powerful physique, he used to amuse the medical students by pointing out that there are no data in the existing tables for computing the basal metabolism of a person of his size and weight Yet, this massive frame did not prevent him from constructing and handling the most delicate instruments and apparatus

Parnas's many friends in Britain and elsewhere will mourn the passing of this exceptional man.

T Mann

NEW FELLOWS OF THE ROYAL SOCIETY

AT the meeting of the Royal Society on March 17, the following were elected to fellowship

Prof D R Bates, professor of applied mathematics, The Queen's University, Belfast, distinguished for his contributions to theoretical atomic physics and its application to the interpretation of phenomena in the earth's atmosphere

E. J H Corner, lecturer in botany, University of Cambridge, distinguished for his researches on fungi and on tropical floras

Prof A H Cottrell, professor of physical metallurgy, University of Birmingham, distinguished or his research work, both theoretical and practical, oncerning the mechanical properties of metals

Prof S Devons, professor of physics, Imperial College of Science and Technology, University of London, distinguished for his researches in nuclear physics, including the investigation of short-lived tates of nuclei

Prof A W. Downie, professor of bacteriology, University of Liverpool, distinguished for his contributions to bacteriology and virology and especially into the viruses belonging to the pox group

Prof. K C Dunham, professor of geology, University of Durham, distinguished for his petrological researches, his work on the genesis of ore deposits, and on the stratigraphy of the north of England

Dr D J Finney, reader in statistics, University of Aberdeen, and director of the Agricultural Research Council's Unit of Statistics, distinguished for his work in the development and application of statistics to biological problems, especially in the field of bioassay

Dr A Fleck, chairman, Imperial Chemical Industries, Ltd, distinguished for his contributions to chemical technology and for his pioneering work on the radioactive elements

Prof K J Franklin, professor of physiology, St Bartholomew's Hospital Medical College, London, distinguished for the application of X-ray cinematography to physiological problems, for work on veins and vascular reflexes, and the history of physiology.

Prof W. P Hawthorne, professor of thermodynamics, University of Cambridge, distinguished for his researches in the combination of thermodynamics and hydrodynamics on which the design of high-speed heat engines is based.

Prof D H. Hey, Daniell professor of chemistry, King's College, University of London, distinguished for his original contributions to the study of free radicals of short life as intermediates in chemical reactions, and to synthetical organic chemistry

Sir Harold Himsworth, secretary of the Medical Research Council, distinguished for his contributions to clinical investigation, and especially for researches into the etiology of diabetes mellitus and liver necrosis.

A. F. **Huxley**, assistant director of research in physiology, University of Cambridge, distinguished for fundamental discoveries concerning the conduction of impulses in nerves, and for developing new methods for the study of nerves and muscles.

Prof. R. W. James, professor of physics, University of Cape Town, distinguished for investigations of the structure of matter through the use of X-rays, and particularly for his studies of thermal motions of atoms in crystals.

Dr. D. Lewis, head of the Genetics Department, John Innes Horticultural Institution, Bayfordbury, Hertfordshire, distinguished for his researches on the genetics and physiology of pollination.

Dr. J. W. Linnett, lecturer and demonstrator in chemistry, University of Oxford, distinguished for his work on molecular structure and on the physical chemistry of combustion and flame propagation.

Prof. A. C. B. Lovell, professor of radio astronomy, University of Manchester, distinguished for his contributions to radio astronomy and in particular for his work on the detection and investigation of meteors by radio methods.

Prof. O. E. Lowenstein, Mason professor of zoology and comparative physiology, University of Birmingham, distinguished for his work on the comparative physiology of the vertebrate labyrinth.

Dr. R. A. Lyttleton, lecturer in mathematics, University of Cambridge, distinguished for his original contributions to theoretical astronomy and astrophysics and for his mathematical researches on rotating liquid masses.

Dr. A. G. Ogston, lecturer in biochemistry, University of Oxford, distinguished for the application of physicochemical principles and methods to biological problems.

Dr. G. Pontecorvo, reader in genetics, University of Glasgow, distinguished for his contributions to genetics, especially by his studies of gene action, gene organization, and systems of variation in fungi.

Dr. J. A. Ramsay, lecturer in zoology, University of Cambridge, distinguished for his analysis of factors controlling the water balance in animals and for the elegance of the micromethods he has devised.

Dr. F. C. Tompkins, reader in physical chemistry, Imperial College of Science and Technology, University of London, distinguished for his experimental and theoretical contributions to the study of physical and chemical adsorption, and the thermal decomposition of ionic solids.

Prof. A. G. Walker, professor of pure mathematics, University of Liverpool, distinguished for his work on the foundations of relativity theory, and for important contributions to differential geometry, including the theory of harmonic spaces and the theory of fibre bundles.

Prof. G. P. Wells, professor of zoology, University College, London, distinguished for his studies relating structure and function to mode of life of invertebrate animals, particularly of polychætes.

NEWS and VIEWS

Royal Geographical Society: Awards

H.M. the Queen has been pleased to approve the award of the Royal Medals of the Royal Geographical Society as follows: *Patron's Medal*, to Dr. John K. Wright, lately director of the American Geographical Society of New York, for services in the development of geographical research and exploration; *Founder's Medal*, to Commander (L) C. J. W. Simpson, leader of the British Expedition to North Greenland, 1952–54. The Council of the Society has made the following awards: *Victoria Medal*, to Sir John Russell, for his studies of soils and agriculture and for services to geographical education; *Murchison Grant*, to Dr. H. C. K. Henderson, lecturer in economic geography, Birkbeck College, London, for studies in economic geography; *Back Grant*, to Captain O. C. S. Robertson, for his journey through the North West Passage in one season in the icebreaker *Labrador*; *Cuthbert Peak Grant*, to D. G. A. Bunker, for geographical exploration and mapping in south-west Arabia; *Gill Memorial*, to Dr. Marjorie Sweeting, lecturer in geography, University of Oxford, for contributions to the physiography of limestone areas; *Mrs. Patrick Ness Award*, to Dr. E. F. Roots, senior geologist, Norwegian–British–Swedish Antarctic Expedition, 1949–52.

University Grants Committee: New Members

The Treasury has announced the appointment of four new members of the University Grants Committee to take the place of retiring members, and of two additional members, bringing the total up to eighteen. The retiring members are Lord Adrian, Dr. J. W. Cook, Prof. G. W. Pickering and Sir David Hughes Parry. The new members are Prof. R. S. Edwards, professor of economics with special reference to industrial organization in the University of London; Dr. Willis Jackson, director of research and education, Metropolitan-Vickers Electrical Co., Ltd.; Prof. R. H. Matthew, professor of architecture in the University of Edinburgh; Prof. P. B. Medawar, Jodrell professor of zoology and comparative anatomy, University College, London; Prof. A. Robertson, Heath Harrison professor of organic chemistry, University of Liverpool; and Sir George Thomson, master of Corpus Christi College, Cambridge.

New Nature Reserves

The new nature reserve at Axmouth – Lyme Regis undercliffs in Devon, declared by the Nature Conservancy on March 16, forms the largest and most important landslip area on the coast of Great Britain. There have been periodic slips from the sixteenth century onward of the chalk and underlying greensand on the Gault and Lower Lias clay which dip towards the sea, the most spectacular being that on Christmas Day, 1839, when nearly 8 million tons of rock subsided from a cliff 375 ft. high, leaving a chasm half a mile long and 200–400 feet in width. The new reserve, which extends along some five miles of coast and covers 708 acres, is primarily of geological interest but has a wide variety of soils and is almost completely covered with vegetation, notably a well-grown natural ashwood. Interesting birds and butterflies are also to be found. The Conervancy hopes to arrange for the improvement of the public foot-path through the reserve as a step owards the proposed South Devon Coastal Path, but permits will be required to undertake research, o collect specimens of animals or plants or to visit parts of the reserve away from the footpath, and applications for such purposes should be addressed o the Conservancy at the Furzebrook Research Station, Wareham

On March 16 also the Conservancy declared an extension of 200 acres to the existing Scolt Head Nature Reserve, bringing the whole of the Island, some five miles long, within the reserve The Island has become a classic site for the study of coastal erosion, sand and shingle bank formation and the development of salt marshes There is a well-established breeding colony of Sandwich terns, and during the autumn and spring migrations many rare birds have been recorded The Island's main botanical interest lies in its wide variety of marine and other plant communities on shingle beach, sand dune and salt marsh Access will not be restricted, but permits will be required to collect specimens of animals or plants within the reserve

Astronautica Acta : New Journal of Astronautics

THE first number of a new quarterly entitled *Astronautica Acta*, the official journal of the International Astronautical Federation, has recently appeared, published by Springer-Verlag, of Vienna, and I. R. Maxwell and Co , Ltd , of London, Paris and New York (1, No 1 , 1955 Pp 60 Annual subscription 62*s* or 8 60 dollars). The journal is edited by Prof F Hecht, of Vienna, assisted by an editorial board consisting of W. von Braun (United States), A Eula (Italy), J M J Kooy (Holland), E Sanger and K Schutte (Germany), L R. Shepherd (Great Britain) and J Stemmer (Switzerland), to any of whom contributions may be sent The first number opens with a general statement on the feasibility of flight through outer space by Prof von Braun, and contains four articles on various aspects of astronautics I Sanger-Bredt makes a critical examination of the experimental methods which have been applied to the problem of understanding the fundamental nature of chemical combustion processes and discusses their results H Strughold writes on conditions in those parts of the atmosphere that are physiologically similar to outer space D F. Lawden discusses the optimal programming of rocket thrust direction with the view of achieving the maximum energy increment in the pay-load over a given period of time, this is of interest in the problem of the most economical method of escaping from an orbit Finally, J Eugster shows that the major effects of cosmic rays on photographic plates are also detectable by means of dyes , this is of practical importance in biological work where the use of photographic plates is unsuitable The format and printing are of the fine quality that one expects of the house of Springer. It is to be hoped that the journal will obtain the support it deserves and that the high standard set by its first part will be maintained

Strategy of Research

IN a paper in *Research*, the Earl of Halsbury, managing director of the National Research Corporation, emphasizes that there is a great wealth of latent research talent in the universities and public laboratories partly engaged on pure research of a comparatively low order of significance and available for redeployment into basic research of a higher order (*Research*, 7, No 12 , December 1954). One condition for this is that a number of major targets in applied research should be selected for general attack The administrative machinery of government science is, through its laboratories and its grant-aiding and development contractual procedure, adequate to cope with any demands made on it, while, through the medium of research associations, some initiative can be taken publicly or semi-publicly in specifying the sort of problems in applied science which could form the basis for civilian development contracts financed at the public expense. The major contribution in initiative must come from industry itself, however, and there can be no substitute for this In Lord Halsbury's opinion, where industry fails to show initiative, this springs less from a conflict of view between commercial and technical management than from their common and reciprocal failure to act in concert on the basis of a rational appreciation of the part that each has to play This failure of the rational is linked to a national preference for the intuitive approach to the taking of decisions. It cannot be expected to change rapidly , its study by the methods of the social sciences is necessary if it is to be understood more deeply

Physical Basis of Temperature Regulation in Man

DURING the past fifteen years there has been a steadily increasing interest among physiologists in the nature of the mechanisms associated with human thermo-regulation In a paper entitled "Physical Basis of Temperature Regulation in Man", Prof E M. Glaser, of the Department of Physiology, University of Malaya, Singapore, presented to the Pan-Indian-Ocean Science Congress held last year in Perth, Western Australia, an appraisal of the present situation in this field. He pointed out that any thermostatic system is imperfect in that it must have a finite load error Owing to the large thermal inertia of the body, a mechanism concerned only with the maintenance of an approximately constant deep-body temperature would be at best inefficient and at worst unstable. The performance is, in fact, profoundly affected by the derivation of thermal information from the surface of the body as well as from the deeper tissues The resulting control is less precisely thermostatic, as is shown by the considerable variations in deep-body temperature which it permits, but has the virtues of increased flexibility and very much more rapid response to changes in environmental conditions. It may be regarded as primarily controlling thermal balance (homeothermokatametry) rather than deep-body temperature (homeothermy) The physiological responses involved in long-term acclimatization to heat and cold present a problem unique in the field of thermostatics, since the continued operation of responses of one sort appears to cause changes in the sensitivity of the whole control mechanism

Scientific Approach to Cancer

THE March issue of the *Practitioner* is devoted mainly to the cancer problem, and besides an article on "Our Present Understanding of the Cancer Cell" by Prof A Haddow, there are review articles on the place of surgery (H Atkins), radiotherapy (A P Wood and R Morrison), chemotherapy (Edith Paterson), endocrinology (B. J Kennedy) in treatment, and, because of its current high incidence, an article (Sir Clement Price Thomas) devoted to carcinoma of the lung. All these summarize the present position very clearly, and it is noteworthy that all the authors foresee the eventual therapeutic solution in some form of chemotherapy. Prof. Haddow's summary of some of the fundamental experimental work is likely to be of interest to many readers of *Nature*, and it can be heartily recommended as giving in small compass an excellent idea of the main scientific approaches to the problem. It shows how we are beginning to regard the first ('initiation') stage of chemical carcinogenesis as being a combination of the chemical or its metabolites with one or more specific tissue constituents, and the second ('promoting') stage as one of continued proliferation or delayed maturation of the 'initiated' cells, with the final stage (neoplasia) emerging after protein deletion. One current view is that the cancer cell is such because it has lost key proteins essential for the control of growth. With the plethora of facts, attempts to arrive at a unifying hypothesis showing how the diverse and very numerous 'initiating' agents all have the same end result is becoming essential. What is the common factor in carcinogenesis induced by aromatic amines, polycyclic hydrocarbons, ionizing radiations, viruses, hormones and even prolonged tissue culture of some normal cells? This article adequately condenses much of the main evidence which has to be embraced in such a hypothesis. Attention is directed to the recrudescence of interest in tumour immunology, though without discussion. The present writer believes that future articles of this type will perforce discuss this subject more and more, for he has himself recently put forward evidence which supports Prof. Haddow's evaluation of its being "the most logical of all approaches".

Radioiodinated Human Serum Albumin

The Radiochemical Centre (White Lion Road, Amersham, Bucks) can now supply human serum albumin which has been iodinated with radioactive iodine-131 to hospitals and research institutions in the United Kingdom in the same way as it supplies iodine-131. The product (Code No. 1*B*.17) is in an isotonic saline solution (*p*H 9·0–9·2), which is sterile and free from pyrogens, and is packed in 10-ml. rubber-capped multi-dose bottles. The specific activity is not less than 5 mc./mgm. albumin, and the minimum concentration is 100 mc./ml. solution. The protein is iodinated uniformly, and the amount of iodine present is less than 0·2 per cent of the weight of albumin. The active iodine is firmly bound to the protein molecules, and not more than 2 per cent of the total activity is in the form of free iodide at the time of dispatch. Particular care is taken to avoid denaturation, and the product cannot be distinguished from the original albumin by electrophoresis. The product is supplied in standard packages containing either 0·2 mc. (£3) or 1·0 mc. (£5), larger quantities up to 5 mc. being available by arrangement (£5 per mc.). The human albumin is supplied by the Ministry of Health free of charge, and the price of the iodinated material includes only the cost of manufacturing and testing.

Effects of Radiations on Human Populations

In an address delivered on January 11 to the California Institute of Technology, Dr. A. H. Sturtevant discussed the hazards of the increase in high-energy radiations to which human populations are already exposed as a consequence of atom and hydrogen-bomb tests and medical and other activities. He distinguished the two types of hazards: those to the exposed individuals and those to their descendants, and emphasized the appalling ignorance in which we are as to the long-term biological effects of radiations. Extrapolating from *Drosophila* to man, the present increase of radiation due to 'fall-out' from bomb tests would be responsible for the conception of 1,800 more individuals per year heterozygous for recessive lethals in the whole world. Dr. Sturtevant stressed that, in view of its social significance, scientists must try to get some idea of how much of what may be happening, and to how many people.

School Nature Study Union

The first number of the fiftieth volume of *School Nature Study*, the journal of the School Nature Study Union, which appears in a new and attractive form, contains details of new activities by the Union (George Philip and Son, Ltd., London. 2*s*. 6*d*.). Besides the usual meetings and excursions which are organized in and around London, some provincial areas are showing interest in the Union's activities, and there is a possibility of a branch being formed in the Midlands. The journal contains some useful hints by John Sankey, assistant warden of the Juniper Hall Field Centre, on the ways of taming wild animals like foxes and badgers, an article by E. T. Cluff on the behaviour of 'winter gnats', and other articles and reports on a number of conferences and meetings.

Tanganyika Agricultural Corporation

The work in Tanganyika of the Overseas Food Corporation is to be continued by a new organization, the Tanganyika Agricultural Corporation, which will come into being on March 30. It will operate in the areas taken over from the Overseas Food Corporation and will be financed for this purpose until September 1957 by a Colonial Development and Welfare grant from the British Government. The new Corporation will also be invited by the Government of Tanganyika to assist in carrying on the Rufiji Basin reconnaissance survey which is at present in progress under the ægis of the United Nations Food and Agriculture Organization. In particular, it will be asked to establish the trial farms that are being planned as part of this investigation. In addition, consideration is being given to other agricultural development projects which might with advantage be undertaken by the Corporation, by agreement with the Government.

Physical Society's Exhibition

The Physical Society's annual Exhibition of Scientific Instruments and Apparatus will be held in the Royal Horticultural Society's New Hall, Greycoat and Elverton Streets, London, S.W.1, on the following dates: April 25, 10.30 a.m.–8 p.m. (Fellows and press only, 10.30 a.m.–2 p.m.), April 26 and 27, 10 a.m.–8 p.m., and April 28, 10 a.m.–5 p.m. The discourses this year will be as follows (each one at 6.15 p.m.): April 25, the free electron as a tool in scientific research, by Mr. M. E. Haine (Associated Electrical Industries, Aldermaston); April 26, memory systems in the brain, by Prof. J. Z. Young (Department of Anatomy, University College, London); and April 27, recent developments in luminescence and its applications, by Dr. G. F. J. Garlick (Department of Physics, University of

Birmingham). As in previous years, the Society is ublishing a "Handbook of Scientific Instruments and pparatus" in connexion with the Exhibition (6s , or s by post) All inquiries should be sent to the ociety at 1 Lowther Gardens, Prince Consort Road, ondon, S W 7

University of Birmingham : Appointments

THE title of reader in organic chemistry in the University of Birmingham has been given to Dr E J Bourne, senior lecturer in organic chemistry The following appointments have recently been made in the University Dr B G Gowenlock, to be lecturer in chemistry , G Webster, Edward Cadbury Fellow in archæology, to be staff tutor in archæology , and S J Lyle, to the J Lyons fellowship in analytical chemistry The title of University research fellow has been given to the following during the tenure of their present posts Dr H Spedding, of the British Cotton Industry Research Association, who is working in the Department of Chemistry, and Dr J S Howell, who is working in the Department of Pathology, for the Birmingham Branch of the British Empire Cancer Campaign Committee

Belgian Physical Society : Officers

AT the annual general meeting of the Société Belge de Physique, held on February 19, the following officers were elected *President,* Prof P Swings Liège) , *Vice-Presidents,* Prof W de Keyzer (Ghent), Prof J. Delfosse (Louvain) and Prof G A Homes Brussels) , *Secretary General,* Dr M C Désirant A C.E C Physics Research Laboratory, Charleroi)

The Night Sky in April

FULL moon occurs on April 7d 06h 35m , U T , and new moon on April 22d 13h 06m The following conjunctions with the moon take place April 10d 03h , Saturn 6° N , April 20d 05h , Venus 7° S , April 25d 02h , Mars 0 7° S , April 28d 02h , Jupiter 3° N In addition to these conjunctions with the moon, Mars is in conjunction with Aldebaran on April 25d 23h , Mars being 6 4° north of Aldebaran. Mercury, in superior conjunction on April 23, is unfavourably placed for observation during the month Venus rises at 4h 40m , 4h 20m and 4h. on April 1, 15 and 30, respectively, and will be visible for a short time before sunrise Its stellar magnitude varies from −3 5 to −3 4, and the visible portion of the illuminated disk from 0 756 to 0 835 , this increase does not compensate for the planet's recession from the earth—from 107 to 124 million miles between April 1 and 30—so that there is a small decrease in brightness Mars sets about 22h 30m. during the month and has an eastward movement in Taurus , its close approach to Aldebaran on April 25 has been pointed out Jupiter remains visible until the early morning hours, its times of setting being 2h. 55m , 2h 05m and 1h 10m at the beginning, middle and end of the month, respectively, and is a conspicuous object in Gemini , in the third week of April it is a little south of κ Geminorum , its stellar magnitude varies from −1 8 to −1 6, the decrease in brightness being due to its distance from the earth increasing from 465 to 508 million miles during the month. Saturn rises at 22h , 21h and 20h on April 1, 15 and 30, respectively, and has a retrograde movement in Libra , its brightness increases by 0 2 mag. during the month, owing to its distance from the earth decreasing from 847 to 828 million miles Only one occultation of stars brighter than magnitude 6 occurs in April, observations being made at Greenwich April 2d 22h 42 1m , *h* Leo (*D*), *D* referring to disappearance. The Lyrid meteor shower attains a maximum on April 21 , the radiant of this shower is at R A 18h , Dec. 33° N.

Announcements

THE Baekeland Memorial Lecture of the Plastics and Polymer Group of the Society of Chemical Industry will be given in the Royal Institution, London, W 1, on June 2, by Dr C E. K. Mees, who will speak on "Leo Hendrik Baekeland and Photographic Printing Papers".

A MEETING is being held under the auspices of the Institute of Biology on April 15 at the Polytechnic, Regent Street, London, W 1, to discuss the place of biology in technical colleges Speakers will include representatives of industry, agricultural research and the Ministry of Education, an external examiner of the University of London and several lecturers from technical colleges The meeting is open to all interested, and further information can be obtained from the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W C 1

THE essay subjects for this year's *Endeavour* prizes of the British Association for the Advancement of Science will be as follows the earth's magnetism , man-made fibres , climatic changes , scientific aids to food supply , respiration , and new metals for engineers The essays must be sent in by June 1 and should not exceed four thousand words. Competitors must be less than twenty-five years of age, and the prizes will be 50, 25 and 15 guineas respectively, with two special awards of 5 guineas to those less than eighteen Further information can be obtained from the Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1

THE Textile Institute is offering a three-year scholarship, of total value £950, which is open to a man of British nationality, and less than twenty-four years of age, to enable him to pursue a three-year course in textile technology at a university, or equivalent, level The Institute is also offering two new scholarships, to be known as the Peter Coats Scholarships, for young men of about school-leaving age to study for a college diploma or other qualifications in subjects connected with the cotton industry. The scholarships will be worth not more than £100 a year, tenable for two or three years in a British technical college The closing date for entries for all these awards is April 30, application forms and further information being obtainable from the General Secretary, Textile Institute, 10 Blackfriars Street, Manchester 3.

FROM £8,000 of the United States Counterpart Funds for economic aid, the Ministry of Agriculture and Fisheries is offering a number of postgraduate scholarships during the academic year 1955–56 for vocational training in the following subjects agricultural economics, farm management, estate management, and land economics and land use The scholarships will be worth £400–800, free of income tax, plus all compulsory fees and other expenses, and are open to British subjects resident in the United Kingdom Application forms, to be returned by April 30, and further information can be obtained from the Secretary, Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, London, N W 1

ORGANIZATION OF APPLIED RESEARCH

EIGHT annual conferences on the administration of research have been held in recent years in the United States. The interest in research administration is growing with its importance, and technical assistance missions sponsored by the Organization for European Economic Co-operation visited research establishments in Western Europe in 1951, and the United States and Canada in 1952. Their observations and conclusions have been published in three volumes under the general title "The Organization of Applied Research in Europe, the United States and Canada" (see *Nature*, **174**, 778 , 1954)

In spite of its manifest importance—it is reported that the United States alone is now spending three billion dollars annually on research—no conference on research organization had been held at an international level until that which took place in Nancy during October 11–15, 1954, arranged by the European Productivity Agency Moreover, it is perhaps significant, and possibly strange to British ideas, that according to one delegate such a conference could not have been convened five years earlier The conference was distinctly European, with about one hundred delegates from Western Europe and with American representatives as observers As such, the many and varied expressions of opinion referred largely to the problems and difficulties of Western Europe

Three separate approaches to the central theme were made on each of three succeeding days The first day was devoted to the subject of "The Practical Organization of Research" , the second to "The Human Factor in Research and Team Work" , and the third to "The Dissemination of Results of Research and their Implementation" Each day's papers and discussion were summarized by a series of 'conclusions' which, it is hoped, will provide springboards for action in the different countries represented

Papers at the first session were delivered by Dr L Henry (Belgium), Dr D W. Hill (Great Britain) and Prof M Letort (France). To some extent the discussion inevitably tended to centre around the relations between universities and industry—a major problem which has not yet been solved in Europe. It was generally considered that, while universities and industry must be brought closer together, each recognizing and, indeed, catering for the needs of the other, the American solution of extensive applied research projects in universities has progressed too far in one direction, to the possible detriment of the pure research function of the university. This led naturally to a discussion of how much applied research a university can undertake, in order to assist industry and strengthen its teaching function without undermining its research function

Attempts to define the problem resulted, despite a plea from the chairman, Dr. A King (Great Britain), in a discussion of the meanings of pure and applied research. In this connexion a phrase used by Prof Maurice Letort (France) sticks in the memory in pleading for a recognition that applied research could often be sufficiently fundamental to satisfy the strictest purists, he described the kind of applied research which could usefully be done in universities, and which is already the main occupation of central research organizations, as "directed basic research" —that is, fundamental research directed to a usefu end It was Prof. Letort, too, who probably gave the last word on this subject Expressing his conviction that the dichotomy of pure and applied research is, in fact, non-existent, he pointed out that since there must be some choice of subject, the academic research worker should choose a field with a big hinterland rather than one which would yield immediate technical results

The conclusions of the session reflected the discussion, especially with their insistence upon the need for applied research, the interdependence of academic research and industrial development, the need to preserve the freedom of academic research and the desirability of governments assisting research of all kinds both directly and by fiscal policies which encourage research expenditure

The discussion on the second day was remarkable in that human factors had never before been discussed at a conference in Europe, and no less so in that the British delegates listened intently but made only one very brief contribution to it. It was evident that the human problems of Continental Europe are not those either of Great Britain or the United States The chairman, Mr V. Lasareff (Organization for European Economic Co-operation), emphasized what is perhaps not generally recognized, namely that, in applied research, productivity depends more upon the human factor than upon any other The importance of the human factor can therefore scarcely be over-estimated There can be little question that, of all the problems of research, the human ones, particularly the reconciliation of the interests of the community with those of the individual, present the widest differences between countries For this reason, the last conclusion of the day, though apparently the most innocuous, may in the long run prove to be the most effective This conclusion adopted a suggestion from Mr. Lasareff that the participating countries should compare their methods for selecting and evaluating staff This should prove a relatively simple, but possibly very rewarding, task for the Organization for European Economic Co-operation.

After recognizing the importance of human problems in research, other conclusions directed attention to the need to provide both prestige and material satisfaction for the research worker, to the need for security, to the recognition of the value of research training for high industrial positions, and to the desirability of selecting research directors as much for their aptitude for leadership as for their scientific knowledge. More controversial, perhaps was a conclusion that education from school-days onwards should aim at emphasizing the importance of research and preparing young people for team work and its discipline

An absorbingly interesting paper on the evening of the second day, by Dr J W. Barker (United States) outlined the conception, philosophy and practice of the Research Corporation of New York, and introduced the subject of the patenting of research results This was followed on the third day by an exposition of his views by Signor L Morandi, vice-president of the Montecatini Company of Italy. The subsequent discussion on patents, though interesting, could scarcely be said to add much to the vast experience gained by the Research Corporation of New York and so fully put at the disposal of the conference by Dr Barker

The remainder of the discussion on the third day was largely concerned with the dissemination of research results Documentation methods were reviewed in detail, and it was concluded that if efficiently pursued they will largely meet the needs of science and technology, but that the conventional methods do not fit the demands of the smaller firms A recommendation was therefore adopted that the European Productivity Agency should encourage study designed to solve this aspect of the problem On a wider approach, it was concluded that the knowledge of the impact of research on a dynamic civilization should be diffused as widely as possible As Dr J S Whitehead (Great Britain) pointed out in his paper, it is desirable to establish a climate of public opinion favourable to science, in order to ensure its widest application in national life Such a climate, when established, affects influential people —those who have the direction of affairs—so that they take decisions in line with the needs of science

To the present writer, at least, it was a matter of regret that more was not said on the implementation of the results of research, for this is a crucial point to which a whole conference might well be devoted We are commonly told that only a small proportion of research results are capitalized, and that many research organizations could now be well employed ensuring the application of past results for the benefit of industry, rather than piling up new ones to be cast into the limbo with the old It would be interesting to discuss whether this is true or not, and if so, why Are there multitudinous results potentially valuable to industry, available and unused ? If so, is it the fault of industry or research ? Is it the cost of development or the fear of obsolescence ? Or is it fiscal policies or innate conservatism, either on the part of industry or of its customers—the public ? It is gratifying to know that the Applied Research Division of the European Productivity Agency is now planning a preliminary survey on the development of inventions Its report, when available, might well form the basis of a future conference

As was pointed out during the conference, research has been revolutionized during the past twenty-five years No greater evidence of this could be forthcoming than the holding of such a meeting Nevertheless, it is to be hoped that none of the delegates believes the conference to have been an end in itself It was an opportunity for sharpening wits, comparing notes, receiving new points of view—all with the object of returning to the various countries represented to try them out in practice For, when all is said and done, research organization is not yet a science but an art, and an empirical art at that, so that despite the conclusions no one is likely to dispute the wise words of Prof M Letort, "No authoritarian measure or administrative rule can create that confidence and goodwill which are the essential conditions of fruitful collaboration", which is the basis of successful research. With this background, the delegates naturally accepted a final conclusion that a similar conference dealing with the aspects of co-operation in research should be held in a year or two's time

It would be ungracious to conclude this report without a reference to the excellent arrangements made for the conference by the European Productivity Agency and the University of Nancy The success of the occasion was due in no small measure to the meticulous organization , and the gratitude of the participants will be directed especially to the rector of the University, Dr J Capelle, who also acted as secretary of the conference and who was unsparing in his efforts on their behalf

D W Hill

AERATION IN INDUSTRIAL FERMENTATIONS

On January 12 the Society for Applied Bacteriology and the Microbiology Group of the Society of Chemical Industry held a joint meeting to discuss "Aeration in Industrial Fermentations" Dr L A Allen was in the chair Both the microbiological and the physical aspects of the subjects were considered, four papers being given and a short film shown

In the opening paper, by A L Downing and G A Truesdale, Mr Downing described some factors affecting the rate of solution of oxygen in water The data were obtained from laboratory experiments designed to provide information about re-aeration in a polluted estuary Relatively small changes in rate of solution of oxygen, expressed as an exit coefficient, resulted from the action of mixing currents or of air-streams forced tangentially over the surface, provided that the surface remained largely undisturbed Increasing the rate of mixing beyond the point at which vortices were formed caused a rapid increase in exit coefficient, high rates of solution being ultimately attained Similarly, the exit coefficient increased rapidly as the surface was increasingly disturbed by air-streams having velocities exceeding a critical value equivalent to 6–7 m /sec at 10 m above the surface Increasing the height or frequency of waves, generated mechanically, caused an approximately linear increase in exit coefficient Under different conditions of surface agitation the exit coefficient increased linearly with increasing temperature in the range 0–35° C The mean value of the temperature coefficients of the exit coefficient (defined as the increase in exit coefficient expressed as a percentage of the value at 20° C per deg C increase in temperature) was 2 37 Films of oil on the surface caused little effect until their thickness exceeded 10^{-4} cm. Except when fracture of the film occurred, the exit coefficient was steadily reduced as the thickness was increased from 10^{-4} cm to 10^{-1} cm Soluble surface-active agents, on the other hand, caused reductions in rate of solution which increased with increasing concentrations up to 1 0 p p m but which tended to a limiting value

The mechanics of bubble formation was then discussed by Mr R H Bowers, who prefaced a description of his experimental work with a review of data obtained by other investigators Datta and his co-workers showed that the measured size of bubbles issuing from a single open-ended tube, at low rates of flow of gas, agreed approximately with a theoretical formula derived by equating surface tension and buoyancy forces As the rate of flow of gas was increased, the bubbles became larger Van Krevelen has suggested a mechanism from which expressions for the size of both very large and small bubbles can be derived In many industrial fermentations high flows of gas are required, and, if a simple perforated sparger is used, large bubbles are formed, which can lead to poor aeration Bubbles produced from porous diffusers having a large number of orifices and a low rate of flow through each are in some cases smaller than would be predicted from the theoretical equations A mechanism to account for this has been suggested and confirmed experimentally by Pattle The properties of the liquid have a pronounced effect in these cases If a mycelium is built up during fermentation, bubbles become trapped and coalesce. In Mr Bowers's experiments the rate of absorption of oxygen from bubbles formed with a porous ceramic plate was reduced by a factor of 20 by 2 per cent of paper pulp added to simulate mycelium This factor was reduced to approximately 7 by agitating the liquid above the plate with a turbine-type stirrer In an apparatus in which dispersion of the gas was brought about by the mechanical agitator itself, the effect of the paper pulp was reduced still further to a factor of about 2

Mr P E Sawyer presented a paper by Prof F H Garner and himself on surface-active effects within gas bubbles The presence of surface-active agents in solution may appreciably influence the behaviour of rising gas bubbles owing to the formation of an adsorbed film at the bubble interface. The principal effect of such an adsorbed interfacial film is to modify the hydrodynamic properties at the gas–liquid interface. Normally the interface between a rising bubble and a liquid permits the transmission of viscous shear across it, resulting in the formation of toroidal circulation currents within the bubble The drag exerted by the liquid on a circulating bubble is lower than that exerted if the bubble acts as a solid spheroid, and the velocity of ascent of the bubble is thus increased The presence of a surface-active agent in the liquid may produce a semi-rigid or rigid structure at the interface which resists the transmission of shear and may inhibit or completely suppress circulation

Mass transfer between a rising bubble and a liquid is also dependent on the character of the interfacial film Internal circulation is accompanied by a considerable reduction in the resistance to mass transfer in both phases Thus an adsorbed film will reduce mass transfer-rates by inhibiting circulation, in addition, the film may itself constitute a resistance to mass transfer, possibly by molecular interaction or by mechanical obstruction The presence of surface-active agents may have an important secondary effect upon the path and shape of a rising bubble Over a certain velocity-range bubbles normally rise with a spiral motion, surface contamination, however, changes this into a zig-zag motion in one plane The reduction in surface tension produced by surface-active agents may also lead to changes in the shape of the bubble and to an increased tendency to oscillation

The effects of certain variable factors on the formation and behaviour of gas bubbles in water, some of which had been referred to by the speakers, were strikingly demonstrated, in slow motion, in a short film The effects of varying the rate of flow of gas, the diameter of the hole from which the bubbles were formed, and the motion of the water were shown Dyes injected into the liquid or polarized light were used for illustrating the characteristics of the fluid dynamics around the bubble

Dr G N Rolinson dealt with the effects of aeration on fungal metabolism One of the striking differences between moulds and bacteria is that there are no anaerobic moulds It is extremely doubtful whether any growth takes place when fungi are completely deprived of oxygen Aeration is frequently a limiting factor in fungal cultures, increased aeration increasing both the amount and rate of growth, and increased aeration frequently results in an increased rate of respiration, since a more extensive respiratory mechanism is synthesized The respiratory quotien of mycelium grown under conditions of high aeration may be more than double that of mycelium grown under low aeration One respiratory mechanism developed in response to the level of aeration appears to be the cytochrome system. Mycelium of *Penicillium chrysogenum* oxidizes lard oil rapidly when grown under conditions of high aeration, but only slowly when grown under conditions of low aeration High rates of aeration are essential for high yields o penicillin Maximum rate of penicillin production by washed mycelium of *P. chrysogenum* has been found to be dependent on the mycelium being permitted to respire at its maximum rate. This is similar to effects observed in citric acid production whereas, in contrast, the maximum production of α-amylase occurred when the rate of respiration was below the maximum In addition to the yeasts, many of the Mucors and Fusaria also carry out vigorous alcoholi fermentation when deprived of air Under aerobi conditions, alcoholic fermentation is depressed, and so also is the rate of glycolysis. Thus, the Pasteu effect, is probably caused by a lack of inorgani phosphate under aerobic conditions Aeration may also effect metabolism by sweeping away carbon dioxide which might otherwise be assimilated

The subjects raised in the lively discussion following the papers covered a wide field. Questioner were interested in methods of deoxygenation of water in the design of absorption vessels and stirring mechanisms and in the performance of different type of aeration systems Methods of measurement o dissolved oxygen concentrations were considered Several speakers cited instances in which polarographic techniques had been used with success Th general opinion was that aeration studies could be o considerable value in improving practical fermentation processes, although rate of aeration was no always a factor limiting rate of production Impedances in the organisms themselves were sometime the controlling factor. In replying to question arising out of his paper, Dr Rolinson said tha yeasts grown aerobically would probably not grow afterwards in complete absence of oxygen, althoug some growth might occur in partially anaerobi conditions. With regard to the Pasteur effect, thi is not a permanent alteration of the enzyme system He agreed that impedance across the cell wall canno readily be distinguished from inability of enzym systems to utilize oxygen when it became available

---

TREND AND PATTERN OF FERTILITY IN GREAT BRITAIN

THE sixth, and final, volume of the Papers of th Royal Commission on Population describes th family census of 1946—its origins, methods an defects—and goes on to analyse in great detail th information collected The joint authors are Pro D V Glass, of the London School of Economics, an Prof E Grebenik, of the University of Leeds

The family census was taken because some of th most important demographic questions with whic the Royal Commission on Population was concerne could not be answered in any other way. Since the normal census machinery could not be used, the family census was taken on a sample basis, the desired information being collected from a 10 per cent random sample of the women in Great Britain who were, or had been, married. It had no statutory sanction, but just over 87 per cent of the women responded—a very high response for a voluntary investigation. The extent of bias arising from non-response was examined, and it was found that any effect on the validity of the results could be safely discounted.

In part, the examination of the results follows the pattern customarily found in fertility censuses, in which the basic tables relate to the total number of children which the women had had by the time of the census. These tables show, for example, that of the women covered by the family census, 66 per cent had had not more than two children, and only 9 per cent had had six or more. On average, each woman had 2·3 live births by the time of the census. Dividing the women into two broad social groups, manual and non-manual (based on the husband's occupation), the corresponding averages are 2·52 and 1·90 live births.

Study of the information by date of marriage shows clearly the decline in family size: for example, a woman married in 1920 had only about half as many children as a woman married before 1890—about 2·5 children in the former case, and about 5 in the latter. Whereas in the late nineteenth century families of five or more children constituted three-fifths of all families, the marriages of 1925 were dominated by one- and two-child families. Over this period, too, childlessness had doubled in frequency.

The statistics for all marriages (including childless marriages) show a consistent fall in family size with increasing age at marriage. But it is also shown that the relation between age at marriage and final family size is becoming somewhat less rigid. This is the kind of development which would be expected with the increasing acceptance of 'family planning' and with the spread of the small family.

A special feature of the family census was that the date of birth of each child was recorded. This information made possible the comparison of the families of different groups of marriages after different durations of marriage. For example, it was possible to compare the families, after six years of marriage, of women married in 1930 with the families, after six years of marriage, of those married in 1940. Such comparisons have enabled the authors to give a much clearer picture of current trends, and to make some tentative suggestions about the future.

The statistics show that the fall in family size has been accompanied not so much by a more wide-spread spacing between births, as by a contraction in the span of years during which children are born.

The general trend of ultimate family sizes, as deduced from the partial records available, shows a continued but slow fall in size of completed family for the marriages up to 1930, a fluctuating stability for the marriages of 1931–40, and thereafter a suggested increase in family size.

The data on family sizes have also been used for constructing replacement-rates indicating whether, with a continuance of fertility, marriage and mortality at certain specified levels, the population would ultimately increase or fall. For the women born in 1895–99, the estimated rate is only 0·74, well below the 1·0 which would show adequate long-term replacement of population. For more recent generations the replacement-rates will be higher, but the complete record of childbearing is not yet available. Marriage-rates have, however, been calculated and give a reasonably clear picture of the situation. Taking the marriages of 1941–43, the estimated rate ranges between 0·94 and 0·98, and this, although based in part on projected data because the families of these women are not completed, serves to suggest that the replacement-rates likely to result from recent marriages are not far from 1·0.

Far greater difficulties arise in attempting to predict the future of family size. Examination of the data suggests that family limitation is even more widespread in Britain than has been previously estimated, and that a further substantial fall in fertility is unlikely to occur simply through an extension of family planning. The analysis suggests that a new stability has developed in recent years, and that there may in fact have been some increase in family size since the Second World War. These developments have accompanied the spread throughout the community of the small-family pattern; nothing so far visible in the statistics foreshadows a major departure from that pattern in the near future.

NATIONAL RESEARCH DEVELOPMENT CORPORATION

REPORT FOR 1953–54

THE chief feature of the report and statement of accounts of the National Research Development Corporation for the year ended June 30, 1954*, is the quinquennial review of the Corporation's work, and this will be discussed separately. Among the new development projects in which the Corporation has interested itself during the year is a stereoscopic ciné camera, the development of which might be advantageous for educational, medical, scientific and technological purposes, and a technique for simplifying and economizing in the wiring of electric circuits.

Of projects already referred to in previous reports, the electronic digital computer continues to be the Corporation's largest single project, more than £325,000 of the £928,000 borrowed by the Corporation representing stocks, work in progress or patent expenditure in this field. Six big computers of the University of Manchester type have been ordered and have been or are being built for the Corporation's account, of which five have been sold and will have been delivered during 1954–55. The much less costly 401 Mark I computer has been transferred to Rothamsted Experimental Station after completing its trials at the Mathematical Laboratory, Cambridge, and is in routine use for calculations relating to agricultural statistics and other purposes. The design of a further computer embodying many of the successful devices in the prototype 401 has also been decided. The Packman potato harvester is now out of the development stage, and a number of machines are being made for the harvest this year. The Ricardo light steam-engine is now available for exploitation, and good progress has been made with the process of extracting hecogenin from sisal juice and purifying it to hecogenin acetate. Production and marketing of the chick sexer and aural microscope are proceeding satisfactorily.

---

* National Research Development Corporation. Report and Statement of Accounts for the Year 1st July, 1953, to 30th June, 1954. Pp. 20. (London: H.M.S.O., 1955.) 9d. net.

Of the 664 inventions communicated to the Corporation during the year, 268 were from government departments and research councils, 50 from Commonwealth official organizations, 18 from industrial research associations, 38 from universities and 269 from British firms and individuals. The rights of 375 patents and patent applications were assigned to the Corporation during the year, of which 315 were from government departments and research councils, 14 from industrial research associations, 30 from universities and 8 from British firms and individuals. The Corporation now holds some 2,647 United Kingdom and overseas patents and patent applications, and, of the 272 licence agreements with industry in force, 99 were revenue-earning, producing £27,650 during the year.

CENTRAL LABORATORIES FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, HYDERABAD

REPORT FOR 1953

THE annual report[*] for 1953 of the Central Laboratories for Scientific and Industrial Research, Hyderabad, stresses the increasing number of postgraduate students—twenty-two were working in the Laboratories for their Ph.D. in 1953—as evidence of the increasing contribution of the Laboratories both in training and in scientific and technical research. The research staff now numbers fifty-eight, and the report lists twenty-five papers published during the year, apart from forty communicated to the forty-first Indian Science Congress, held at Hyderabad in 1954.

In the Oils Section of the Laboratories, work was carried out on local bleaching earths, and on the preparation of dehydrated castor oil giving completely tack-free films and of alkyd resins modified by castor oil. The solubility and effectiveness of aca-catechin and katha-catechin as antioxidants in ghee were studied, the separation of fatty acid mixtures by adduct formation with urea was shown to be a much simpler method than conventional methods, and a suitable method was worked out for refining cotton-seed oil on a cottage-industry basis. The Entomology Section continued its studies of the toxicity of the seed oil from *Annona squamosa* (sitaphal) to vertebrates, and this oil appears to be fungistatic rather than fungicidal to *Helminthosporium* (paddy). The Paper Section was placed on a semi-commercial scale, and good progress was made in the manufacture of drawing paper and bond paper. In the Fuel Section the erection of the 12 ton/day ovoid briquetting plant was completed and the plant put into operation, experiments on binders for low-temperature tar continued. Further work was carried out on the distillation of low-temperature tar, the solvent extraction of tar acids and hydrocarbons from coal tar oils, and on benzole recovery from the low-temperature carbonization gas, while a systematic survey of the coalfields of Hyderabad commenced in July 1953.

The Heavy Chemicals and Fertilizers Section was occupied with the utilization of felspar (including studies of bricks from felspar sludge and on the influence of silica on the recovery of potash by the calcination process) and of iron pyrites (including the preparation of manganese dithionate, manganous sulphate and sulphur), the preparation of activated charcoal from teak-wood sawdust and from groundnut hulls, and the thermal decomposition of manganese sulphate and calcium sulphate to produce sulphur dioxide. The Ceramics Section made a systematic study of Hyderabad clays and the preparation of fireclay refractories from such clays. Investigations on potential synthetic analgesics in the Organic Chemistry, Pharmaceuticals and Drugs Section covered compounds of the quinazoline type and a new synthesis of pethidine. Studies on Indian turpentine included the preparation of a chlorinated product which was highly toxic to various insect tests, and work on the synthesis of menthol. In the work on compounds with œstrogenic activity, stilbene compounds were obtained by condensation of 3-chlorobutanone with phenol or its ethers in presence of sulphuric acid or anhydrous aluminium chloride, but the reaction is not general for α-halogeno ketones. The synthesis of 'Vanitrope' (2-ethoxy-5-propenylphenol) is being attempted and also the preparation of fine chemicals from fusel oil, while a series of ketones obtained by condensing lævulinic acid with aromatic aldehydes are being examined as plant growth regulators.

The Biochemistry Section has given its attention chiefly to the fermentation of pre-treated molasses to citric acid, to itaconic acid fermentation, to oxidations by *Pseudomonas fluorescens* and to the nitrogenous constituents of the seed cake of *Annona squamosa*. In the X-ray Section, X-ray studies were made of Hyderabad and Indian clays, while the Physical Chemistry Section investigated the conductivity of sulphuric acid in aqueous acetone and ethyl alcohol and the titration of tartaric acid with potassium dichromate. Besides the erection of the 25-ton/day low-temperature carbonization pilot plant, the Chemical Engineering Section completed work on the saturation solubilities of groundnut oil and cottonseed oil in aqueous ethyl alcohol and was further equipped with pilot-plant items for cottonseed processing, vacuum distillation and the manufacture of synthetic resins.

[*] Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1953. Pp. x+64. (Hyderabad—Deccan: Central Laboratories for Scientific and Industrial Research, 1954.)

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON

REPORT FOR 1953–54

THE forty-seventh annual report of the governing body of the Imperial College of Science and Technology, London, covering the year ended July 31, 1954[*], gives some details of the immediate proposals for expansion. Licences have already been granted for the erection of an additional story over the Goldsmiths' Company's extension to the City and Guilds College and the Royal School of Mines building, the first part of the extension of the chemical engineering building and the addition of two stories to the Union building. In January this

[*] Imperial College of Science and Technology. Forty-seventh Annual Report of the Governing Body, 1953–1954. Pp. 65. (London: Imperial College of Science and Technology, 1955.)

The Technique & Significance of Oestrogen Determinations

MEMOIR 3 OF THE SOCIETY FOR ENDOCRINOLOGY

The report of a symposium, likely to interest both clinicians and research workers, published as the third of the *Memoirs* edited for the Society by P. ECKSTEIN and S. ZUCKERMAN. 18*s. net*

Linearized Theory of Steady High-Speed Flow

G. N. WARD

An account of the present state of the more important aspects of the linearized theory for applied mathematicians and aerodynamicists working on high-speed flow CAMBRIDGE MONOGRAPHS ON MECHANICS AND APPLIED MATHEMATICS 30*s. net*

An Introduction to Stochastic Processes

M. S. BARTLETT

A stochastic process is any actual process with some statistical or chance element in its structure. This book deals with the new mathematical and statistical techniques for studying such processes. 35*s net*

CAMBRIDGE UNIVERSITY PRESS

THE WORLD'S GREATEST BOOKSHOP

FOYLES

FOR BOOKS

FAMED CENTRE FOR SCIENTIFIC BOOKS

Bookbuyers throughout the world turn to this bookshop as a knowledgeable source of information on all their book requirements.

And from generation to generation they praise and recommend Foyles—and buy their books here

Foyles have depts for Gramophone Records, Music, Stationery, Handicraft Tools and Materials, Magazine Subscriptions, Lending Library, Foreign Stamps.

119-125 CHARING CROSS ROAD
LONDON WC2

Gerrard 5660 (16 *lines*) ★ *Open* 9–6 (*inc. Sats*)

Two minutes from Tottenham Court Road Station

Introduction to

Nuclear Engineering

By RAYMOND L. MURRAY

Professor of Physics, North Carolina State College of Engineering

After defining what is meant by nuclear engineering and describing its broad scope, Dr Murray discusses in detail the technology and problems of atomic energy in all its phases. An indispensable text-book for the student of nuclear physics *Illustrated* 30s.

Atoms in the Family

By LAURA FERMI

The wife of the designer of the first atomic pile tells of their life together. A gay, endearing biography of a charming family it sketches the personalities of many of the present atomic scientists *Illustrated* 18s.

GEORGE ALLEN & UNWIN LTD
40 Museum Street, London, W.C.1

Volume I : Table of Contents

1. Introduction. Meson Physics and Field Theory

I. ONE-PARTICLE RELATIVISTIC WAVE EQUATIONS

2. The Klein-Gordon Equation
3 The Dirac Equation
4. Transformation Properties and Magnitudes of Dirac Operators
5 Properties of the Dirac Equations
6. Application of the Relativistic Wave Equation for One Particle
7. Calculational Aids
8 Feynman's Positron Theory
9. Applications of Feynman's Theory

II. FIELD THEORY

IIA. Fields and Interaction
10. The Lagrangian Formalism
11. Interaction Between Fields
12. Interaction with the Electromagnetic Field
IIB Quantum Theory of Fields
13 Field Quantization
14. Scattering and the S Matrix
15 The Covariant Formalism
16. The Invariant Perturbation Theory
17. Reduction of the S Matrix
18. Feynman Diagrams
19. Momentum Space Considerations
IIc. The Renormalization Program
20. The Self-Energy of a Fermion
21. Renormalization
22. The Divergences
23. Renormalizable and Non-Renormalizable Theories
24. Quantitative Renormalization Theory
25. Recent Developments
26 The Equivalence Theorem

Volume II : Table of Contents

III. MESON PHYSICS

IIIA. Properties of Pi Mesons
27. General Properties of Pi Mesons
28. Spin and Parity of Pi Mesons
IIIB. Meson Scattering
29. Scattering of Pi Mesons by Protons · General
30. Isotopic Spin in Nuclear Physics
31. Isotopic Spin Formalism in Meson Theory
32. Phase Shift Analysis
33 Low Energy Scattering Experiments
34. High Energy Scattering (above 120 Mev)
IIIc. Photoproduction
35. Photomeson Production · Theoretical Background
36 Photomeson Production Experiments
37. Photomeson Production Interpretation
IIID Meson Theory
38 The Old Strong Coupling Theory
39. Development of Meson Theory 1947–1953
40. The Tamm-Dancoff Method
41 The Relativistic Integral Equation for Meson Scattering
42. On the Solution of the Integral Equation
43 Renormalization Problems
44 Theoretical Questions
45 Recent Theories of Photoproduction of Mesons
46. The Magnetic Moment of the Nucleon
47 Theory of Nuclear Forces
IIIE Meson Production of Particles
48 Production of Mesons by Nucleon Collisions
49. Multiple Meson Production
IIIF. Other Mesons
50. The Mu Meson
51. "Curious" Particles

New . . .

MESONS

AND FIELDS

Volume I : FIELDS

by HANS A BETHE, *Laboratory of Nuclear Studies, Cornell University*, SILVAN S. SCHWEBER, *Carnegie Institute of Technology*; and FREDERIC DE HOFFMANN, *Los Alamos Scientific Laboratory, University of California.*

Volume II : MESONS

by HANS A. BETHE and FREDERIC DE HOFFMANN

VOLUME I is a self-contained textbook of the modern development of field theory The presentation is simple and close to familiar concepts

Starting from a review of the one-particle relativistic wave equations, it proceeds to the subject of field quantization In this, the emphasis has been on the Feynman-Dyson graphical techniques for the S-matrix expansion. Renormalization theory is discussed in detail. In addition, an outline of very recent developments is presented

This material serves as background to understand meson phenomena, but it can be studied without reference to Volume II.

VOLUME II, which is essentially self-contained, will be of interest to both experimentalists and theorists It presents and analyzes the available experimental information in the field of meson physics Meson theory is treated both phenomenologically and from the field theoretical point of view

Experiments in the field of meson physics are discussed with particular stress on their interrelation and comparison with theory Results obtained by the use of high energy machines in such fields as meson-nucleon scattering and photoproduction are given in some detail Because of the particular importance of pi mesons, the largest fraction of the volume is devoted to a study of these However, sections on the mu meson and the "curious" new mesons, recently discovered, are also included.

The theory sections cover nuclear forces and the magnetic moment of the nucleon A "strong coupling" approach which has recently proved successful is given prominence. Volume I is not prerequisite to any of the phenomenological theory presented in Volume II, nor to most of the field theory

Volume II : Table of Contents (*contd*)

Appendix A—Center-of-Mass Momenta and Wavelength
Appendix B—Center-of-Mass Energies
Appendix C—Relativistic Transformation to Center of Mass

Row, Peterson and Company

EVANSTON, ILLINOIS, U S A

MACMILLAN BOOKS

Science and its Background

H D. ANTHONY, M A.(Cantab), B Sc , Ph.D.(Lond), F R.A.S.

Here is the story of science, with the background of history in which that story is set. Although most of the chapters centre around individual men of science whose work is of value to-day, the historical background is not only that of isolated biography but the continuous history of human affairs. Two chapters, on post-war developments and the pursuit of science for its own sake, have been added for this second edition. *Second Edition* 20*s*.

A Text-book of Electricity and Magnetism

G. R. NOAKES, M.A , F.Inst.P.

This is the new, Third Edition of a book which will meet the need of those taking Intermediate degree courses and the Advanced and Scholarship Examinations of the General Certificate of Education. All the usual topics required at this stage are dealt with, and where necessary calculus is used. Among the special topics discussed are the conduction of electricity through gases, atomic physics and modern views on ferro- and terrestrial magnetism. *Third Edition.* 14*s*.

Minerals for Atomic Energy

ROBERT D. NININGER

United States Atomic Energy Commission

This book, now published in this country for the first time, is sub-titled *A Guide to Exploration for Uranium, Thorium and Beryllium.* It is a complete handbook, covering the geology of these minerals, their incidence in America and elsewhere, their identification, the equipment to use in exploration, etc., and the evaluation of the results of successful searching. 55*s*.

Plane Algebraic Curves

E. J. F. PRIMROSE, M.A (Oxon.)

The aim of this book is to give the student who is unfamiliar with the theory of curves a reasonably brief introduction to the subject, there being no other elementary book still in print he should then be in a position to study the more advanced works. Though the book is intended for honours mathematics students at a university, the first few chapters could be studied with profit by advanced sixth-form pupils in schools 15*s*.

All prices are net

St. Martin's Street, London, W.C.2

Just published—

CHEMISTRY AND CHEMICAL TECHNOLOGY OF COTTON

Edited by KYLE WARD, Jr
The Institute of Paper Chemistry, Appleton, Wisconsin

CONTENTS . The Chemistry of Lint Cotton (Composition, by **J. D. Guthrie** ; Chemical Properties of Cotton Cellulose, by **C. M. Conrad**) Sizing, by F. G. La Piana Bleaching, by **E. I. Valko.** Dyeing, by **R. E. Rupp.** Printing and Related Processing of Cotton Fabrics, by **A. E. Hirst.** Mercerization, by **C. F. Goldthwait.** Water-Resistant Treatments, by **H. A. Schuyten.** Fire Resistance, by **J. M. Church** and **S. Coppick.** Treatment of Cotton to Provide Mildew and Rot Resistance, by **G. A. Greathouse** and **C. J. Wessel.** The Use of Resins for Creaseproofing, Shrinkproofing, Glazing, and Embossing Cotton Fabrics, by **D. H. Powers.** Treatment of Cotton for the Rubber Industry, by **E. T. Lessig, M. W. Wilson** and **H. C. Hebden.** Testing and Evaluation of Cotton Textiles, by **R. K. Worner.** The Laundering of Cotton Fabrics, by **J. F. Oesterling.** Chemical Changes in Cotton Fabrics during Processing and Use, by **J. D. Dean.** Glossary, Author Index. Subject Index

1955 6 × 9 801 pages, with illustrations. 160*s.*

INTERSCIENCE PUBLISHERS LTD.
88-90 CHANCERY LANE. LONDON. W.C.2

SINGER
Micromanipulators

Singer (High-power) Micromanipulators are suitable for use under magnifications of from × 100 to × 1,000 diameters *plus*, as described by Barer and Saunders-Singer in the *Quarterly Journal of Microscopical Science*, Vol. 89, pp. 439-447, December, 1948

Singer Microdissectors (Low-power Micromanipulators) are suitable for use under magnifications of from 1 to ×200 diameters and are described by Barer and Saunders-Singer in the *Journal of Scientific Instruments*, Vol. 28, pp. 65-68, March 1951.

●

SINGER INSTRUMENT COMPANY LTD.
83, London Street, Reading

THE MUSEUM BOOK STORE, LTD.
25 Devonshire St., London, W.1
(Welbeck 1340)
Buy and sell Scientific Journals and Periodicals and Learned Society Publications, in all languages Librarians, and others, should send us their list of "wants", or duplicates for sale. *Binding undertaken.*

Scientific Circulations Ltd.
We have extensive stocks of Technical Journals, Periodicals and Textbooks Special terms for Technical and Commercial Libraries. All Scientific and Technical publications purchased.
111, Eastbourne Mews, London, W.2
Telephone AMBassador 6934

WHELDON & WESLEY, LTD.
Specialists for 100 years in
BIOLOGICAL & GEOLOGICAL BOOKS
Catalogues on Request
●
83/84 BERWICK STREET • LONDON • W.1
Books Bought

ANALYSIS OF DEVELOPMENT

BENJAMIN H. WILLIER, Professor of Zoology, Johns Hopkins; PAUL A. WEISS, Member, Rockefeller Institute for Medical Research; VIKTOR HAMBURGER, Professor of Zoology, Washington University.

735 pages. 248 figures 105s.

A work of great distinction which presents a summary of the present state of knowledge, and problems under investigation, of the stages of embryological development of animal organisms. Each chapter is written by a specialist with the editorial supervision of three eminent embryologists. *It is of great importance and outstanding authority.*

THE VERTEBRATE BODY

ALFRED SHERWOOD ROMER, Professor of Zoology and Director, Museum of Comparative Zoology, Harvard University.

New (2nd) Edition. 644 pages, 390 figures. 49s.

In preparing this revision of his successful book, Dr. Romer has been very alert to the comments made by fellow teachers of Comparative Anatomy. Approximately 2,000 changes have been made in the text and these have improved the overall clarity of the book.

W. B. SAUNDERS COMPANY LTD.
7 GRAPE STREET, LONDON, W C 2

WANTED TO PURCHASE

Scientific books & periodicals

Entire libraries, and smaller collections;
sets and runs, foreign and domestic.

WALTER J. JOHNSON, INC.
125 East 23 Street, New York, 10, N.Y., U.S.A.
Cable Address BOOKJOHNS, NEW YORK
British Office: ACADEMIC BOOKS, LTD.
129 Queensway, London, W.2

The SCIENTIFIC BOOK SUPPLY SERVICE
(T FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals

PHONE: CEN 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

World's Largest Stockists of Scientific Periodicals

COMPLETE LIBRARIES PURCHASED

BUYING?
Suppliers to all Leading Universities, Public Libraries and Institutions of the World. Catalogues issued.

★

SELLING?
Specialists in Scientific, Technical Books and Publications of all Learned Societies.

★

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1
Telephone: Wel. 7948; Amb. 5991

The Use of Stereographic Projection in Structural Geology
By F. C. PHILLIPS, M.A.
96 pages 95 illustrations 15s. net

The Coalfields of Great Britain
Edited by SIR ARTHUR TRUEMAN, K.B.E., D.Sc., F.R.S.
408 pages 113 illustrations 63s. net

Coal. Its Formation and Composition
By W. FRANCIS, M.Sc.Tech., Ph.D.
554 pp. 204 illustrations 103 tables 84s. net

Geometrical Optics
By C. CURRY, Ph.D.
181 pages 123 diagrams 21s. net

Sound. A Physical Textbook
By E. G. RICHARDSON, Ph.D., D.Sc.
Fifth edition
360 pages 121 diagrams 25s. net

Wave Motion and Sound
By R. W. B. STEPHENS, Ph.D., and A. E. BATE, Ph.D.
456 pages 356 illustrations 45s. net

Books on the design of apparatus
edited and compiled on behalf of
the Institute of Physics by
RUTH LANG, Ph.D.

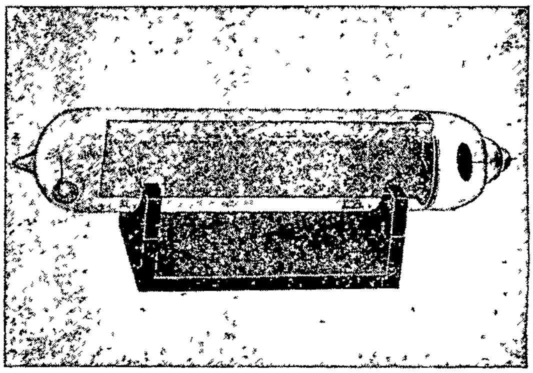
Laboratory and Workshop Notes
284 pages 195 illustrations 21s. net

Further Laboratory and Workshop Notes
300 pages 185 illustrations 28s. net

Laboratory and Workshop Notes 1950–1952
292 pages 185 illustrations 30s. net

EDWARD ARNOLD
41 Maddox Street, London, W.1

DEMONSTRATION VACUUM TUBES
for
SCHOOLS, COLLEGES, ETC.



SOLUS ELECTRONIC TUBES LTD.
15/18 Clipstone Street
Gt. Portland Street, London, W.1

H. K. LEWIS & Co. Ltd.

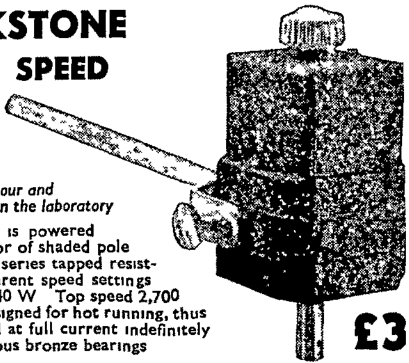
★ **STATIONERY DEPARTMENT** ★

A Comprehensive range of Sectional Designers' Papers, Graph Books and Pads. Sheets and Pads of Logarithmic—"Z" Charts—Circular Percentage—Reciprocal—Probability—Binomial—Logistic—Log Logistic—Triple Co-ordinate—Polar Graph—Impedance Charts—Time Table (Gantt)—Daily, Weekly, and Monthly Charts, etc., held in stock

Catalogues sent on application

H. K. LEWIS & Co. Ltd., 136 Gower Street
Telephone] **LONDON, W.C.1** [*EUSton* 4282

THE PICKSTONE VARIABLE SPEED STIRRER UNIT



designed to lighten labour and expedite experiments in the laboratory

This STIRRER UNIT is powered by an induction motor of shaded pole type incorporating a series tapped resistance, giving ten different speed settings. Power consumption 40 W. Top speed 2,700 R.P.M. Windings designed for hot running, thus motor may be stalled at full current indefinitely. Oil impregnated porous bronze bearings

£3
Including packing and post in U.K.

Sole Manufacturers R. E. PICKSTONE LTD.,
56-60 Islington Park Street, London, N.1
Telephone *CANonbury* 6190

NEW ZEALAND

SCIENCE REVIEW

(11 *issues per annum*)
covers scientific activities in New Zealand
reports original research; book reviews
NEW ZEALAND SCIENCE ABSTRACTS.
25s. per annum

DIRECTORY OF

NEW ZEALAND SCIENCE

(*Third Edition*)
lists individual scientists; learned societies
institutions and Government laboratories
New Zealand scientific publications
secondary school teachers; trade section.
20s.

OFFICIAL PUBLICATIONS OF

NEW ZEALAND ASSOCIATIONS OF SCIENTISTS

Address enquiries to
The Hon. Editor, P O. Box 1874, Wellington, C.1,
New Zealand.

* * * *

For details of advertising space in both publications apply:
London Office
47 Gresham Street, London, E.C.2. MONarch 7644

*Catalogue 675**

BOOKS

ON THE

HISTORY OF SCIENCE & TECHNOLOGY

●

Antiquarian, New & Secondhand
English, American and Foreign

**Gratis on application*

W. HEFFER & SONS LTD.

3-4, Petty Cury, Cambridge

Telephone 58351 *Telegrams: Heffer, Cambridge*

Hutchinson's

For publication in April 1955

A GUIDEBOOK TO ELECTRICITY

J. H. M. Sykes, A.M.I.E.

Information needed by all users of electricity in the home, in the workshop and on the road The treatment of the book is essentially explanatory and describes, primarily for the layman, how electricity is generated, distributed and used Also many technicians may learn a great deal from it 21*s*

MAN AND THE WINDS

Aubert de la Rue

Believed to be the only book that deals at all exhaustively and exclusively with the good and bad influence of the winds on mankind The use of wind as a source of power for driving ships and for machinery, including the generation of electricity and its effect on the siting of towns and on architecture, are fully covered.

Translated from the French by Madge Thompson 16*s*.

Both the above books are fully illustrated

LIFE, THE GREAT ADVENTURE

Jean Rostand and Paul Bodin

A series of discussions broadcast on the French radio between one of the most eminent biologists and a high-ranking scientific journalist.

The translation is by A. Houghton Brodrick, who has himself a high reputation as a writer in the wide sphere covered by the book. 12*s*. 6*d*.

FULL CATALOGUE AVAILABLE
ON REQUEST

Scientific & Technical Publications

RECENT SCIENTIFIC and TECHNICAL BOOKS

Volumes marked with an asterisk (*) have been received at "Nature" Office

Mathematics

ADCOCK, C J Factorial Analysis for Non-Mathematicians Demy 8vo. Pp 88 (Melbourne Melbourne University Press, London Cambridge University Press, 1954) 17*s* 6*d* net *

BAKST, Aaron Mathematical Puzzles and Pastimes Demy 8vo. Pp vii+206 (New York D Van Nostrand Company, Inc, London Macmillan and Co, Ltd, 1954) 27*s* net *

FISHER, Sir Ronald A Statistical Methods for Research Workers (Biological Monographs and Manuals—No 5) Twelfth edition, revised Med 8vo Pp xv+356 (Edinburgh and London Oliver and Boyd, Ltd, 1954) 16*s* net *

GREEN, S L Advanced Level Pure Mathematics Part 2 Pure Geometry and Trigonometry Second edition Pp iv+129–284+iv 6*s*. Part 3 Algebra and Analysis Pp iv+285–624 12*s*. Ex Cr. 8vo (London University Tutorial Press, 1954)*

MACROBERT, T M. Functions of a Complex Variable Fourth revised edition Demy 8vo Pp xvi+422. (London Macmillan and Co, Ltd, New York St Martin's Press, Inc, 1954) 2(*s* net

STUDIES IN MATHEMATICS AND MECHANICS, presented to Richard von Mises By Friends, Colleagues and Pupils Med 8vo Pp ix+353. (New York Academic Press, Inc, London Academic Books, Ltd, 1954) 9 dollars *

UNITED STATES DEPARTMENT OF COMMERCE National Bureau of Standards Table of the Gamma Function for Complex Arguments (Applied Mathematics Series, No 34) Large Post 4to Pp xvi+105 (Washington, D C Government Printing Office, 1954) 2 dollars *

Physics

BLANC-LAPIERRE, A, et PERROT, M Conductibilité Électrique des Lames Métalliques Minces (Mémorial des Sciences Physiques—Fascicule 57) Super Royal 8vo Pp iii+96 (Paris Gauthier-Villars, 1954) 1100 francs *

COLOMBANI, M. A. Propriétés Magnétiques des Lames Métalliques Minces (Mémorial des Sciences Physiques—Fascicule 58) Super Royal 8vo Pp iii+78 (Paris Gauthier-Villars, 1954) 1000 francs *

DOUCET, M Y Les Aspects Modernes de la Cryométrie (Mémorial des Sciences Physiques—Fascicule 59) Super Royal 8vo Pp iii+78 (Paris Gauthier-Villars, 1954) 1650 francs *

GUGGENHEIM, E A, and PRUE, J E Physicochemical Calculations (Series in Physics) Med 8vo Pp xii+491 (Amsterdam North-Holland Publishing Company, 1955) 26 50 guilders, 53*s*, 7 dollars *

HUNT, Frederick V Electroacoustics The Analysis of Transduction, and Its Historical Background (Harvard Monographs in Applied Science —No 5) Demy 8vo Pp ix+260 (Cambridge, Mass Harvard University Press, New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 48*s* net *

POINCARÉ, H. Électricité et Optique La Lumière et les Théories Électrodynamiques Deuxième édition, revie et complétée par Jules Blondin et Eugène Neculcea (Cours de Physique Mathématique) Med 8vo Pp x+641 (Paris Gauthier-Villars, 1954) 2000 francs *

VON HIPPEL, Arthur R Dielectrics and Waves Demy 4to Pp xii+284 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 128*s* net *

Engineering

AHRENDT, William R Servomechanism Practice Med 8vo Pp vii+349 (London McGraw-Hill Publishing Company, Ltd, 1954) 50*s* *

BIEZENO, C B, and GRAMMEL, R Engineering Dynamics Vol I Theory of Elasticity—Analytical and Experimental Methods (Translated from the original German by M L Meyer) Super Royal 8vo Pp xi+307 (London and Glasgow Blackie and Son, Ltd, 1955) 50*s* net *

GROB, Bernard Basic Television Principles and Servicing (McGraw-Hill Television Series) Second edition Med 8vo Pp xv+660 (London McGraw-Hill Publishing Company, Ltd, 1954) 64*s* *

KRUGMAN, Leonard M Fundamentals of Transistors Demy 8vo Pp iv+140 (New York John F Rider Publisher, Inc., London Chapman and Hall, Ltd, 1954) 21*s* net *

MANNING, G P Reinforced Concrete Arch Design Second edition Demy 8vo Pp 192 (London Sir Isaac Pitman and Sons, Ltd, 1955) 30*s* net

REINER, M (edited by), Ward, A G (with the assistance of) Building Materials Their Elasticity and Inelasticity (Deformation and Flow—Monographs on the Rheological Behaviour of Natural and Synthetic Products) Med 8vo Pp xv+560 (Amsterdam North-Holland Publishing Company, 1954) 42 guilders, 84*s* *

STUBBINGS, G W Automatic Protection of AC Circuits Fourth revised edition edited by C M Dobson Demy 8vo Pp 355 (London Chapman and Hall, Ltd, 1954) 50*s* net

ZWORYKIN, V K, and MORTON, G A Television The Electronics of Image Transmission in Colour and Monochrome Second edition Med 8vo Pp 1037 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 140*s* net

Chemistry · Chemical Industry

BURNETT, G M Mechanism of Polymer Reactions (High Polymers—a Series of Monographs on the Chemistry, Physics, and Technology of High Polymeric Substances—Volume 3) Med 8vo Pp xv+493 (New York Interscience Publishers, Inc, London Interscience Publishers, Ltd, 1954) 80*s* *

COLOWICK, S, LAZAROW, A, RACKER, E, SCHWARZ, D. R, STADTMAN, E., and WAELSCH, H (edited by) Glutathione Proceedings of the Symposium held at Ridgefield, Connecticut, November, 1953 Med 8vo Pp x+341 (New York Academic Press, Inc., London Academic Books, Ltd, 1954) 7 50 dollars *

CORLEY, H M (edited by). Successful Commercial Chemical Development. Med 8vo Pp 374 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 62*s* net

HESSE, Gerhard, and WEIL, Herbert Michael Tswett's First Paper on Chromatography 8 in × 5¾ in Pp 35+2 plates (Eschwege M Woelm, 1954) n p *

HOLLINGSHEAD, R G W Oxine and Its Derivatives Vol I Oxine—Part I Pp x+322+x Vol 2 Oxine—Part 2 Pp v+323–616 Royal 8vo (London Butterworths Scientific Publications, 1954 42*s* net each volume *

HOLNESS, H Inorganic Qualitative Analysis Semi-Micro Methods Cr 8vo Pp vii+150. (London Sir Isaac Pitman and Sons, Ltd, 1954 12*s* 6*d*

MEE, A J Physical Chemistry Fifth edition, prepared in collaboration with D M S Wheeler Demy 8vo Pp xviii+726 (London William Heinemann, Ltd, 1954) 25*s* *

OTT, Emil, SPURLIN, Harold M, and GRAFFLIN, Mildred W (edited by) Cellulose and Cellulose Derivatives (High Polymers—a Series o Monographs on the Chemistry, Physics and Technology of High Polymeric Substances—Vol 5) Med 8vo Pp viii+511–1056 (New York Interscience Publishers, Inc, London Interscience Publishers, Ltd 1954) 12 dollars *

PALIT, Santi R, DAS, Mihar Nath, and SOMAYAJULU, G R Non Aqueous Titration a Monograph on Acid-base Titrations in Organic Solvents Large Post 8vo Pp viii+122 (Calcutta Indian Association for the Cultivation of Science, 1954) 3 rupees, 1 dollar, 5*s* *

PRESCOTT, Frederick Intermediate Chemistry Inorganic and Physical Sixth edition Demy 8vo. Pp viii+828 (London University Tutorial Press, 1955) 21*s* *

WEISSBERGER, Arnold (edited by). Technique of Organic Chemistry Vol I Physical Methods of Organic Chemistry—Part 3 Second completely revised and augmented edition Med 8vo Pp xi+2097–2530 (New York Interscience Publishers, Inc, London Interscience Publishers, Ltd, 1954) 8 50 dollars *

WINSOR, P A Solvent Properties of Amphiphilic Compounds Roya 8vo Pp ix+207 (London Butterworths Scientific Publications 1954) 40*s* net *

Technology

MARYON, Herbert Metalwork and Enamelling a Practical Treatise on Gold and Silversmiths' Work and Their Allied Crafts Third edition, revised Demy 8vo Pp xvi+331+29 plates (London Chapman an Hall, Ltd, 1954) 36*s* net *

MODERN PETROLEUM TECHNOLOGY Second edition Med 8vo Pp viii+702 (London Institute of Petroleum, 1954) 35*s* *

MOLLOY, E (edited by) Electric Wiring (Domestic) Fifth edition Cr 8vo Pp 280 (London George Newnes, Ltd, 1954) 8*s* 6*d* net

REVIEW OF TEXTILE PROGRESS Vol 5, 1953 Ex Cr 8vo Pp 588 (Manchester Textile Institute, Bradford Society of Dyers and Colourists, 1954) 35*s*, 5 dollars *

SEWELL, George H Making and Showing Your Own Films Larg Post 8vo Pp viii+320 (London George Newnes, Ltd, 1954) 21*s* net

THIRD INTERNATIONAL CONFERENCE ON HOT DIP GALVANIZING held at Oxford, 4th–9th July 1954 an Edited Account of the Proceeding at the Conference, with Texts of the Papers Presented, and Revised Discussions of Them Royal 8vo Pp ix+268 (Oxford Zinc Development Association, 1954) 42*s* *

Astronomy

PRICE, Derek J (edited by, from Peterhouse MS 75 I) The Equatorie of the Planetis With a Linguistic Analysis by R M Wilson Demy 4to Pp xvi+214+14 plates (Cambridge At the University Press, 1955 52*s* 6*d* net *

SIDGWICK, J B Amateur Astronomer's Handbook Demy 8vo Pp 580 (London Faber and Faber, Ltd, 1955) 63*s* net *

WURM, K Die Kometen (Verständliche Wissenschaft—Dreiundfünfzigster Band) Cr 8vo Pp vii+160 (Berlin Springer-Verlag 1954) 7 80 D marks *

Meteorology Geophysics

EVE, A S (the late), and KEYS, D A Applied Geophysics in the Search for Minerals Fourth edition Demy 8vo Pp x+382. (Cambridge At the University Press, 1954) 40*s* net *

LUDLAM, F H, and SCORER, R S Further Outlook Demy 8vo Pp. 174+13 plates (London Allan Wingate (Publishers), Ltd, 1954 15*s* net *

Geography · Travel

ASPINALL, Sir A The Pocket Guide to the West Indies. Tenth revised edition Fcap. 8vo Pp 494. (London. Methuen and Co, Ltd 1954.) 30*s* net.

BALCHIN, W G V Cornwall An Illustrated Essay on the History of the Landscape. (Making of the English Landscape Series) 9 in × 7 in Pp 128+61 plates (London Hodder and Stoughton, Ltd, 1954) 16*s*

BYGOTT, John An Introduction to Mapwork and Practical Geography Fifth edition Fcap 4to Pp. viii+251 (London University Tutorial Press, 1955) 14*s* 6*d*

EGGLESTON, G T Tahiti a Voyage Through Paradise Demy 8vo Pp 192 (London Robert Hale, Ltd, 1954) 16*s* net

LOFTHOUSE, Jessica. West Pennine Highway Demy 8vo Pp 189 (London Robert Hale, Ltd, 1954) 18*s* net

PREECE, D M, and WOOD, H R. B Modern Geography Book I Foundations of Geography Seventh edition. Demy 8vo. Pp viii+344 (London University Tutorial Press, 1954) 8*s* 6*d*

General Biology : Natural History Botany : Zoology

BANNERMAN, David Armitage The Birds of the British Isles Volume 3 Sylvidae, Turidae, Prunellidae, Troglodytidae, Cinclidae, Hirundinidae Large Post 4to Pp viii+399+51 plates (Edinburgh and London Oliver and Boyd, Ltd, 1954) 45*s* net *

BLAIR, Henry A (edited by) Biological Effects of External Radiation (National Nuclear Energy Series—Manhattan Project Technical Section. Division 6—Volume 2) Med 8vo Pp xviii+508 (London McGraw-Hill Publishing Company, Ltd, 1954) 56*s*.*

BROWN, R, and DANIELLI, J F (edited by) Symposia of the Society for Experimental Biology No 8 Active Transport and Secretion Royal 8vo Pp vii+516 (Cambridge At the University Press, 1954 Published for the Company of Biologists on behalf of the Society for Experimental Biology) 45*s* net *

BUZZATI-TRAVERSO, Adriano A (edited by) Symposium on Genetics of Population Structure, Pavia, Italy, August 20–23, 1953 (International Union of Biological Sciences Series B—No 15) Super Royal 8vo Pp 141 (Pavia Libreria Internazionale Garzanti, 1954) 2 30 dollars *

HEILBRUNN, L V, und WEBER, F (herausgegeben von) Protoplasmatologia Handbuch der Protoplasmaforschung Band I Grundlagen I Die Makromolekulare Chemie und Ihre Bedeutung für die Protoplasmaforschung Von Hermann Staudinger und Dr Magda Staudinger Pp iv+73 33*s* Band 2 Cytoplasma E4 The Enzymology of the Cell Surface By Aser Rothstein E5 Tension at the Cell Surface By E Newton Harvey Pp iv+116 48*s* Super Royal 8vo (Wien Springer-Verlag, 1954)*

JOHNSON, Frank H, EYRING, Henry, and FOLISSAR, Milton J The Kinetic Basis of Molecular Biology Med 8vo Pp ix+874 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 120*s* net *

LEE, Addison E, and BRELAND, Osmond P Laboratory Studies in Biology Demy 4to Pp xii+253 (New York Harper and Brothers, London Hamish Hamilton, Ltd, 1954) 28*s* net *

McCUBBIN, W A The Plant Quarantine Problem a General Review of the Biological, Legal, Administrative and Public Relations of Plant Quarantines, with special Reference to the United States Situation (Annales Cryptogamici et Phytopathologici—Volume 11) Med 8vo Pp 255 (Copenhagen Ejnar Munksgaard, 1954) 32 kronor, 33*s* 9*d*, 4 80 dollars *

MARSDEN-JONES, E M, and TURRILL, W B British Knapweeds a Study in Synthetic Taxonomy Demy 8vo Pp xiii+201+27 plates (London Ray Society, c/o British Museum (Natural History), 1954 Sold by Bernard Quaritch, Ltd, 11 Grafton Street, W 1) 27*s* 6*d* *

MARSHALL, N B Aspects of Deep Sea Biology Med 8vo Pp 380+5 plates (London Hutchinsons Scientific and Technical Publications, 1954) 35*s* net *

MORLEY, Derek Wragge The Evolution of an Insect Society Demy 8vo Pp 215+31 plates (London George Allen and Unwin, Ltd, 1954) 18*s* net *

POCHON, J, avec la collaboration de AUGIER, J, de BARJAC, H, MARTRE-COPPIER, O, CHALVIGNAC, M A, et LAJUDIE, J Manuel Technique d'Analyse Microbiologique du Sol (Monographies de l'Institut Pasteur) Royal 8vo Pp viii+124 (Paris Masson et Cie, 1954) 750 francs *

SCANGA, Franco La Cellula Batterica Super Royal 8vo Pp xix+477 (Roma Il Pensiero Scientifico, 1954) 8000 lire *

STEBBINS, Robert C Amphibians and Reptiles of Western North America (McGraw-Hill Field Guide Series) Med 8vo Pp xxiv+528 (104 plates) (London McGraw-Hill Publishing Company, Ltd, 1954) 68*s* *

TITSCHACK, Erich (herausgegeben von) Beiträge zur Fauna Perus Nach der Ausbeute der Hamburger Sudperu-Expedition 1936, anderer Sammlungen, wie auch Grund von Literaturangaben Band 4 Wissenschaftliche Bearbeitungen Imp 4to Pp vii+386. (Jena Veb Gustav Fischer Verlag, 1954) 32 D marks *

TWEEDIE, M W F, and HARRISON, J L Malayan Animal Life Demy 8vo Pp x+237 (London Longmans, Green and Co, Ltd, 1954) 18*s* net *

WAGNER, R Probleme und Beispiele Biologischer Regelung Super Royal 8vo Pp viii+219. (Stuttgart Georg Thieme Verlag, 1954) 29 40 D. marks *

Agriculture · Horticulture : Forestry

HAGEDOORN, A L Animal Feeding (Agricultural and Horticultural Science Series) Demy 8vo Pp xix+364+21 plates (London Crosby, Lockwood and Son, Ltd, 1954) 18*s* net *

HELLYER, A G L Simple Rose Growing Cr 8vo Pp 112 (London W H and L Collingridge, Ltd, 1954) 7*s*

STEBBING, E P The Creeping Desert in the Sudan and Elsewhere in Africa, 15° to 13° Latitude Super Royal 8vo Pp ii+165+28 plates (Khartoum Ministry of Agriculture) n p *

TUKEY, H B (edited by) Plant Regulators in Agriculture Med 8vo Pp x+269 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 44*s* net *

Biochemistry . Physiology

COSSA, Paul La Cybernétique du Cerveau Humain aux Cerveaux Artificiels (Collection Évolution des Sciences—No 4) Med 8vo Pp 100 (Paris Masson et Cie, 1954) 525 francs *

DARMADY, E M, and DAVENPORT, S G T Hæmatological Technique for Medical Laboratory Technicians and Medical Students Royal 8vo. Pp viii+197+4 plates. (London J. and A. Churchill, Ltd, 1954.) 18*s*. net.*

HOFFMANN-OSTENHOF, Otto Enzymologie Eine Darstellung für Chemiker, Biologen und Mediziner. Super Royal 8vo Pp xvi+772. (Wien Springer-Verlag, 1954) £9 10*s* 6*d* *

PREECE, I A The Biochemistry of Brewing Med 8vo Pp vii+393. (Edinburgh and London Oliver and Boyd, Ltd, 1954) 25*s* net *

SEBRELL, Jr, W H, and HARRIS, Robert S (edited by) The Vitamins Chemistry, Physiology, Pathology Vol 3 Med 8vo Pp xiii+665. (New York Academic Press, Inc, London Academic Books, Ltd, 1954) 15 dollars *

SEDDON, H J (edited by) Peripheral Nerve Injuries By the Nerve Injuries Committee of the Medical Research Council (Medical Research Council Special Report Series—No 282) Royal 8vo Pp xvi+451 (London H M Stationery Office, 1954) 55*s* net *

THE NATIONAL FORMULARY, 1955 Fcap 8vo Pp 210 (London British Medical Association and The Pharmaceutical Society of Great Britain, 1955) 5*s* (interleaved, 8*s*) *

Anthropology : Archæology

CLARK, J G D Excavations at Star Carr, an Early Mesolithic Site at Seamer, near Scarborough, Yorkshire. With Chapters by D. Walker, Dr. H Godwin, F C Fraser and J E King Appendix by John W Moore Demy 4to Pp xxiii+200+24 plates (Cambridge At the University Press, 1954) 63*s* net.*

MUKHERJEE, R, RAO, C R, and TREVOR, J C The Ancient Inhabitants of Jebel Moya (Sudan) With appendices by Frank Addison and the Authors (Occasional Publications of the Cambridge University Museum of Archaeology and Ethnology—3) Cr 4to Pp xii+124+3 plates (Cambridge At the University Press, 1955) 40*s* net

THOMPSON, J E S The Rise and Fall of Maya Civilization Med 8vo Pp xii+287 (Oklahoma University of Oklahoma Press, 1954) 5 dollars

Philosophy : Psychology

ADAMS, Donald K, AMMONS, R B, BUTLER, John M, CATTELL Raymond B, HARLOW, Harry F, MAIER, Norman R F, MOWRER, O H, SNYGG, Donald, SPENCE, Kenneth W, WICKENS, Delos D, and WITTENBORN, J R (contributed by) Learning Theory, Personality Theory, and Clinical Research—The Kentucky Symposium Med 8vo. Pp ix+164 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1954) 28*s* net *

BERGMANN, Gustav The Metaphysics of Logical Positivism Demy 8vo Pp x+341 (London Longmans, Green and Co, Ltd, 1954) 42*s* net *

FERM, Vergilius A Dictionary of Pastoral Psychology 8½ in × 5½ in. Pp xi+336 (New York Philosophical Library, 1955) 6 dollars *

LEWIS, John Marxism and the Irrationalists Cr 8vo Pp v+141. (London Lawrence and Wishart, Ltd, 1954) 8*s* 6*d* net *

RUNES, Dagobert D (edited by) Treasury of Philosophy Demy 8vo Pp xxiv+1280 (New York Philosophical Library, 1955) 15 dollars *

TAYLOR, Sir Thomas Murray The Discipline of Virtue Reflections or Law and Liberty (Riddle Memorial Lectures Twenty-sixth Series) Demy 8vo Pp 56 (London Oxford University Press, 1954) 5*s* net

Miscellany

BERDYAEV, Nicolas Christianity and Anti-Semitism (Translated by Alan A Spears and Victor B Kanter) Ex Cr 8vo Pp ii+58 (New York Philosophical Library, 1954) 2 75 dollars *

BOKSER, Rabbi Ben Zion From the World of the Cabbalah The Philosophy of Rabbi Judah Loew of Prague Demy 8vo Pp x+210 (New York Philosophical Library, 1954) 3 dollars *

BROWNE, Charles E Henry Edward Armstrong Educational Work Demy 8vo Pp xiii+26+4 plates (London Christ's Hospital, 26 Great Tower Street, 1954) 6*s* *

CAMERON, H C Mr Guy's Hospital, 1726–1948 Med 8vo Pp xiv+520+36 plates (London Longmans, Green and Co, Ltd, 1954) 30*s* net *

CRAMER, Frederick H Astrology in Roman Law and Politics (Memoirs of the American Philosophical Society—Volume 37) 12 in × 9½ in Pp. x+291 (Philadelphia American Philosophical Society, 1954) 5 dollars *

CURLE, Richard The Ray Society a Bibliographical History Demy 8vo Pp vi+101+2 plates (London Ray Society, c/o British Museum (Natural History), 1954 Sold by Bernard Quaritch, Ltd, 11 Grafton Street, W 1) 10*s* 6*d* *

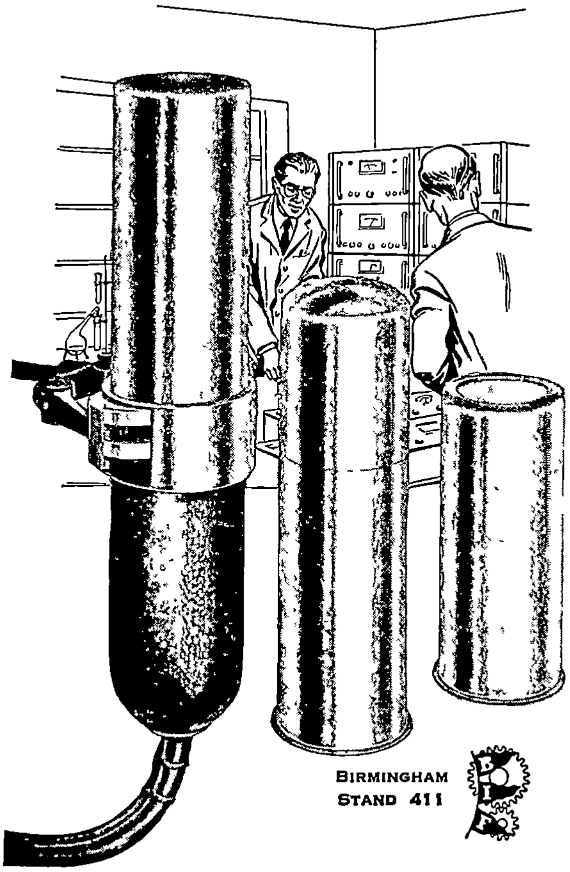
GALE, George W John William Bews a Memoir Super Royal 8vo Pp 140 (Pietermaritzburg University of Natal Press, 1954) n p *

MOSSNER, Ernest Campbell The Life of David Hume Royal 8vo Pp xx+683+20 plates (Edinburgh and London Thomas Nelson and Sons, Ltd, 1954) 42*s* net *

ROYAL SOCIETY Obituary Notices of Fellows of the Royal Society. Vol 9 Super Royal 8vo Pp iii+264+17 plates (London Royal Society, 1954) 30*s* net *

SHAW, James H (edited by) Fluoridation as a Public Health Measure Med 8vo Pp vii+232 (Washington, D C American Association for the Advancement of Science, London Bailey Bros and Swinfen, Ltd, 1954) 4 50 dollars, 40*s* *

STRESEMANN, E, und THOMSEN, Peter (herausgegeben und erläutert von) J F Naumanns Briefwechsel mit H Lichtenstein, 1818–1856 (Acta Historica Scientiarum Naturalium et Medicinalium—Volume 11) Royal 8vo Pp 74 (Copenhagen Ejnar Munksgaard, 1954) 10 kronor *



BIRMINGHAM
STAND 411

SCINTILLATION COUNTER HEAD

TYPE 653

A universal unit for fundamental research into nucleonics—medical, clinical and diagnostic routine investigation.

Special end caps and lead collimator are provided with this equipment for Alpha, Beta and Gamma rays, X-Ray Spectrometry and neutrons using crystalline and plastic phosphors

Ancillary Isotope Apparatus available for complete scintillation techniques includes:

EXTREME STABILITY E H T UNIT, WIDE BAND AMPLIFIER, PULSE ANALYSER, SCALER

Detailed specifications from

ISOTOPE DEVELOPMENTS LTD

120 · MOORGATE · LONDON · E.C.2

Telephone METropolitan 9641 (5 lines)

Midland Agent HAWNT & CO LTD, 59 Moor St., Birmingham, 4 (Telephone Central 6871)

Northern Agent A M LOCK & CO LTD, Crompton St, Chadderton Oldham, Lancs (Telephone Main 6744)

Scottish Agent A R BOLTON & CO, 72 Haymarket Terrace, Edinburgh, 12. (Telephone Edinburgh 62446)

The *Auto Camera* Mk.3

A VERSATILE RECORDING INSTRUMENT

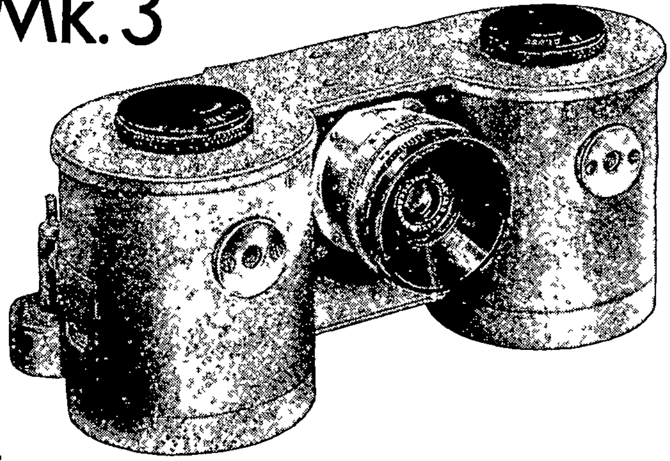
Specially designed to cover a wide field of industrial and scientific work where the rapid production of high quality microfilms is required. It is eminently suitable for such purposes as instrument recording, photomicrography, oscillograph records, process timing, document copying, etc. It is fully automatic in its operation, the exposure and film transport being effected by a single electrical impulse operating on 12 or 24 volt d.c. Special daylight loading cassettes give a full 200 1″ × 1″ or 300 1″ × ¾″ exposures from one loading of 35 mm perforated film. The camera may also be controlled by manual operation

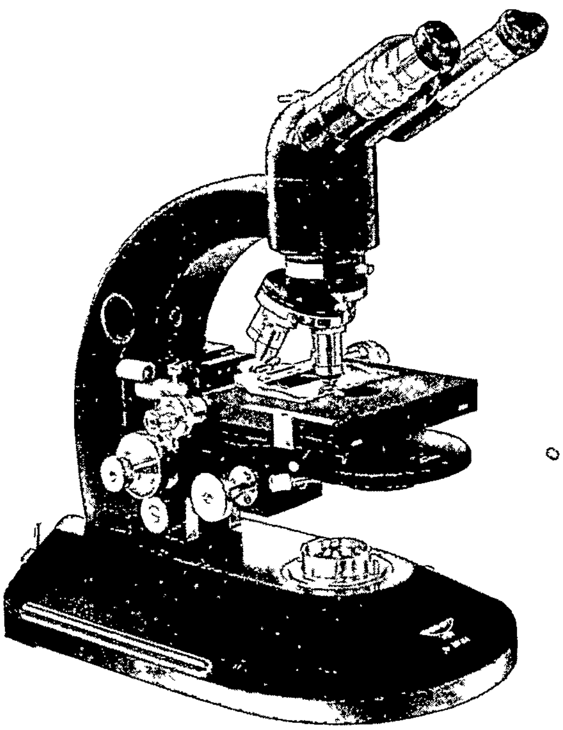
Write for 16-page illustrated brochure.

THE INSTRUMENT DIVISION OF

[illegible]ckman and Sons

CHILTERN. WORKS.
CHESHAM · BUCKS





REICHERT
ANOPTRAL CONTRAST
EQUIPMENT

A new type of phase contrast of higher resolving power, giving images of striking contrast and maximum brilliancy without stray reflections.

Reichert's latest equipment, shown here on the NEOZET Research Microscope, can also be used on any British microscope.

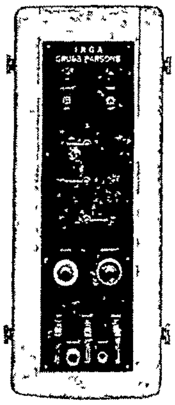
Please write or telephone for a **free copy** *of the* 80-*page booklet "Observations with the Anoptral Microscope" by Prof A. Wilska containing about* 100 *illustrations.*

SHANDON

Phone: KNIghtsbridge 1131

SHANDON SCIENTIFIC COMPANY LTD., 6 CROMWELL PLACE, LONDON, S.W.7

GRUBB PARSONS
Infra Red Gas Analyser



SPECIALLY SUITABLE FOR CONTINUOUS CO_2 ESTIMATION IN FLUE GASES, 0-20% BY VOLUME

(GAS ANALYSERS CAN BE SUPPLIED FOR OTHER GASES AND OTHER RANGES)

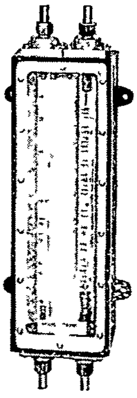
DETAILS OF THE COMPLETE RANGE OF INFRA RED ANALYSERS CAN BE OBTAINED FROM—

SIR HOWARD GRUBB, PARSONS & COMPANY
WALKER GATE, NEWCASTLE UPON TYNE, 6
PROPRIETORS C A PARSONS & COMPANY LIMITED

Measuring

Rate of flow

in analytical work



TYPE 842
Two-way

TYPE 704

The ready availability of accurate but inexpensive Rotameter flowmeters is greatly assisting the development of modern analytical techniques. A number of standard models specially designed for measuring small gas and liquid flows are now available, some of these (e g., Type 704) incorporating fine adjustment valves. Gas flow rates down to 2 ccs/minute are handled.

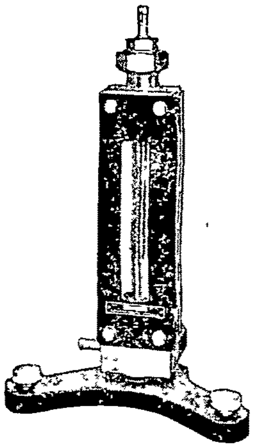
Applications are established in the following —

Gas Analysis — Absorption methods.
— Conductivity measurements.
— Infra-red radiation measurements
— Specific gravity measurements.

Chromatography . Micro Analysis . Flame Photometry (Burner and atomisation control) . Polarography

Write for Catalogue RP 2000/N which gives full details of the Rotameter range of flowmeters

TYPE 825-V



TYPE 126

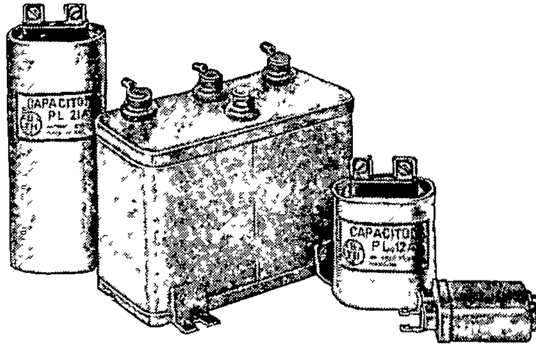
ROTAMETER

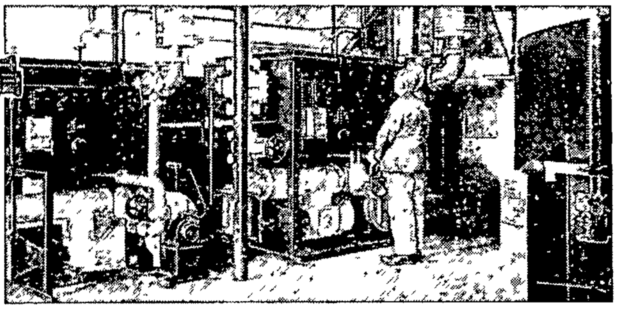
INSTRUMENTS FOR LIQUID AND GAS FLOW MEASUREMENT AND CONTROL

ROTAMETER MANUFACTURING COMPANY LIMITED, 602 Purley Way, Croydon, Surrey. Telephone· CROydon 3816/9.

DRY AIR FOR IMPROVED VACUUM WORK

Thorough insulation impregnation by alternate vacuum and pressure cycles demands the rigid exclusion of moisture from the system by BIRLEC LECTRODRYERS BIRLEC LECTRODRYERS are applicable to a number of electrical applications including the dry blanketing of transformers during assembly, the dry storage of delicate components and insulating material and the drying of gases for lamp filling, electrode annealing etc





A selection of capacitors for fluorescent lighting equipment and ignition units which are vacuum impregnated faster and better by the installation of a Birlec Lectrodryer (Right) Two special Lectrodryers designed for working in conjunction with an insulating impregnation tank
Both photographs are published by kind permission of the British Thomson-Houston Co Ltd

Please send me details of LECTRODRYERS for electrical work
Application
Name
Company
IVW

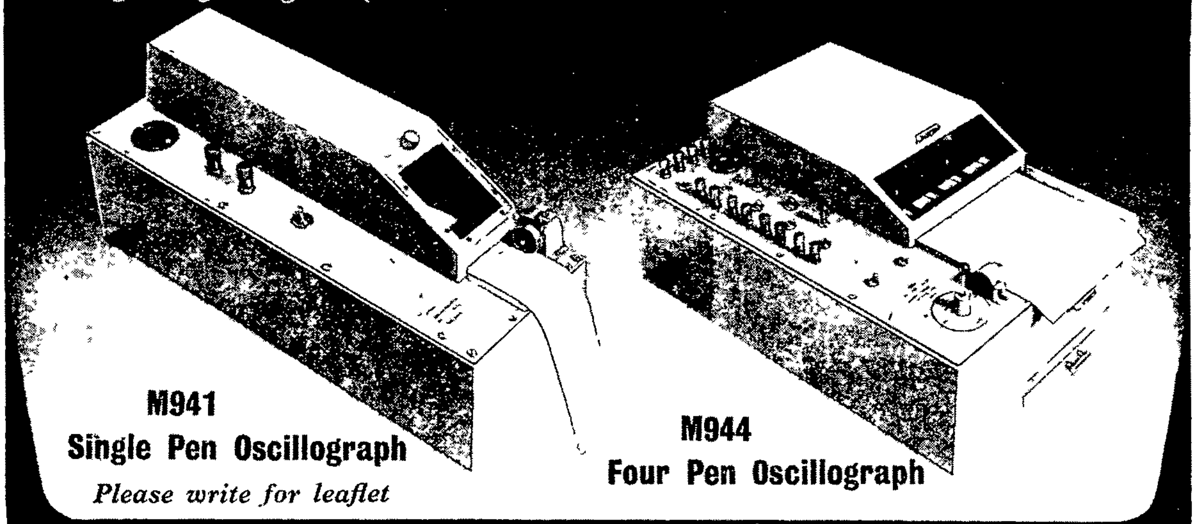
DRYER-DIVISION OF
BIRLEC LTD

ERDINGTON
BIRMINGHAM 24

Member of the AEI Group of Companies.

sm/B 2131 54

MINIRACK PEN OSCILLOGRAPHS



M941
Single Pen Oscillograph
Please write for leaflet

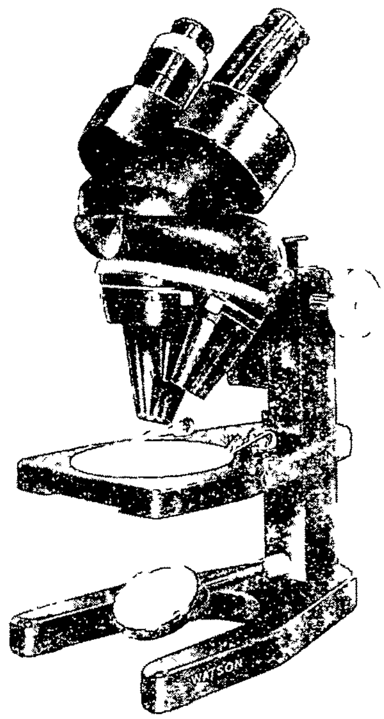
M944
Four Pen Oscillograph

SOUTHERN INSTRUMENTS LIMITED
CAMBERLEY SURREY

Telephone: Camberley 2230 (3 lines) Telegraphic Address: "Minrak, Camberley, England"

Watson Stereoscopic Microscopes will satisfy the most fastidious user

They are available in a wide range of stands and can be fitted with a variety of optics Offering, as they do, a true stereoscopic image, they can be applied to any problem where the three dimensions, length, breadth and depth, are to be investigated The illustration is of the "Research" model Write for List 6B.



WATSON'S

W. WATSON & SONS LTD. 313 HIGH HOLBORN, LONDON, W.C1

high vacua

APIEZON products—always keeping pace with improved techniques developed in the last twenty years—include oils, waxes, greases and sealing compounds designed to produce and maintain the highest vacua now practicable.

Write for the comprehensive booklet which describes their uses in detail.

even to 10^{-8} mm Hg

Shell Chemicals Limited
(DISTRIBUTORS)
Norman House, 105-109 Strand, W C 2 *Tel* TEM 4455

Divisional Offices
Walter House, Bedford St London, W C 2 *Tel* TEM 4455
42 Deansgate, Manchester *Tel* Deansgate 6451
39 Corporation St, Birmingham 2 *Tel* Midland 6954
28 St Enoch Square, Glasgow, C 1 *Tel* Glasgow Central 9561.
53 Middle Abbey St, Dublin *Tel* Dublin 45775
35-37 Boyne Square, Belfast *Tel* Belfast 20081

"APIEZON" is a Registered Trade Mark of Apiezon Products Ltd.

with APIEZON products

Why users in 30 countries choose SOFNOL

non-hygroscopic SODA-LIME.

The up-to-date CO_2 absorbent for:—

★ AIR PURIFICATION in sealed compartments, confined spaces, underground and underwater working places, deep shelters, etc., etc., etc.
★ RESPIRATORS,
★ ANAESTHESIA APPARATUS,
★ OXYGEN ADMINISTRATION,
★ LABORATORY USES—metabolism determination, analytical work, etc.

because of its

★ HIGH ABSORPTION (25% to 40% by weight),
★ RESISTANCE TO ABRASION,
★ FREEDOM FROM HEATING,
★ NON-DELIQUESCENCE,
★ CONSTANT COMPOSITION (BP and USP),
★ LOW STERLING PRICE (No dollars to find).

SOFNOL non-hygroscopic SODA-LIME is supplied in WHITE, GREEN and VIOLET grades, the last two containing indicators which show by colour changes when the product is exhausted
Granule sizes 3/16 in to 14 B S.S. are standard Finer granules down to 30 B.S.S to order. Packed in sealed containers of 1 lb. to 28 lbs and in bulk
SOFNOLITE is the special, self-indicating grade for gravimetric CO_2 determination and general laboratory use. In 1 lb sealed bottles.

SOFNOL

non-hygroscopic

SODA-LIME

The World's most efficient CO_2 absorbent. Write now for full technical data to:—
SOFNOL LTD, Westcombe Hill, Greenwich, S E.10
Telephone. GREenwich 3321/3
"TALK IT OVER WITH **SOFNOL**"

TAS/SL 291

Colloidal Mo S_2

The name of ACHESON COLLOIDS LIMITED has been associated, for over 50 years, with the manufacture of colloidal dispersions of graphite and other solids Now to their well-known range of 'dag' dispersions, they add colloidal dispersions of molybdenum disulphide. This outstanding new lubricant is being applied with great advantage to :—

Die forging, drawing, extrusion and cutting of metals,
Lubrication in operations involving high pressure and temperature,
Dry lubrication.

If you are interested in these new developments or in the various applications of our range of products our technical staff will gladly discuss them with you.

dag
DISPERSIONS

of Colloidal Graphite, Molybdenum disulphide, metallic Silver, Titanium dioxide and other substances.

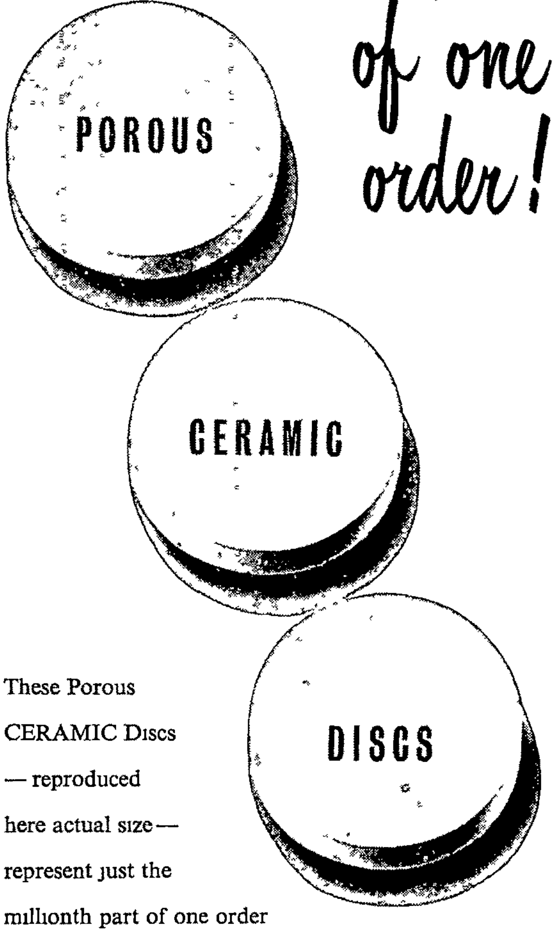
UNITS OF ACHESON INDUSTRIES

ACHESON COLLOIDS LIMITED
18 PALL MALL, LONDON, S.W 1
Telephone WHItehall 2034-7
Telegrams OILDAG, PICCY, LONDON

Also ACHESON COLLOIDS COMPANY
Port Huron, Michigan, U S A
Units of Acheson Industries

TAS/AC 57A

The Millionth part of one order!



These Porous CERAMIC Discs — reproduced here actual size — represent just the millionth part of one order

Do *YOU* use large quantities of Porous Ceramic Discs (or, for that matter, Non-Porous Porcelain or Stoneware) in processing or packaging your products?

If so, it may well pay you to get in touch with us and give details of your particular problem or needs

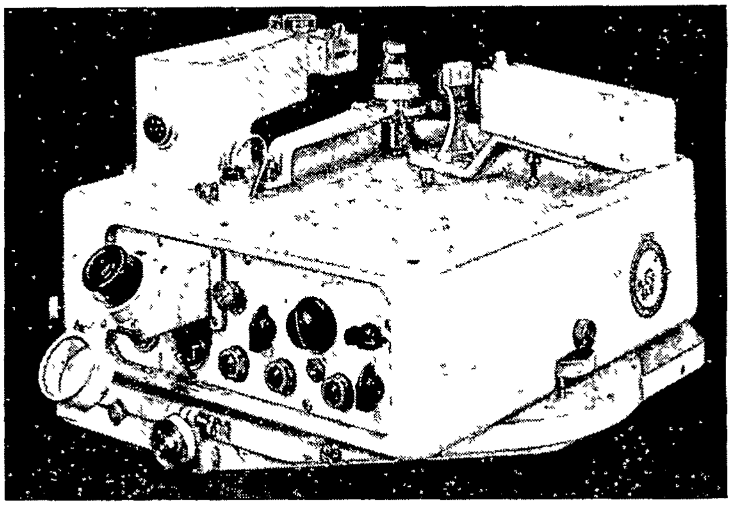
DOULTON & CO. LIMITED
Industrial Ceramics Division, Dept. C,
Doulton House, Albert Embankment,
London, S E 1

Royal
DOULTON
INDUSTRIAL CERAMICS

F35

recording x-ray DIFFRACTOMETER

The Hilger Recording X-ray Diffractometer is designed for the qualitative and quantitative investigation of solid crystalline substances by X-ray diffraction methods without employing photographic processes. It records directly and rapidly the changes of intensity from point to point of an X-ray spectrum.



some of its important features are :

★ Built for use with non-regulated X-ray source.

★ High sensitivity combined with direct reading to 0.01° of 2θ by optical projection.

★ Scan range:
  continuous −10° to +160° of 2θ
  discontinuous—incremental steps over very small angles for exact investigation of weak diffraction lines.
  oscillatory—scan reversal mechanism providing automatic oscillatory motion of detector over arcs ranging from 2.5° to 125° of 2θ

★ Scan speeds—six speeds provided, namely, 2°, 1°, ½°, ¼°, ⅛°, 1/16°, of 2θ per minute.

★ Gearless 2 : 1 drive mechanism between sample holder and Geiger counter ensuring exactness of correlation of motions and freedom from backlash

★ Interchangeable fixed vertical slits.

★ Provision for analysis by fluorescence techniques

★ Three interchangeable specimen holders, indexed to the θ scale, available for Simple Powders, Integrating Types, Blocks.

★ Dual channel electronic control gear for pulse counting or continuous pen recording.

Please write for fully descriptive catalogue CH 322 (N.3)

HILGER & WATTS LTD
98 St. Pancras Way, Camden Road, London, N.W.1, England
Member of the Scientific Instrument Manufacturers' Association and of SCIEX

year it was hoped to start the new joint building for aeronautics and for the further expansion of chemical engineering

The academic plan envisages a much greater rate of increase in the engineering faculty than in the science faculty, with a postgraduate increase of about 160 per cent and an undergraduate increase of about 44 per cent It is hoped to provide eventually for about fifteen hundred undergraduate and fifteen hundred postgraduate students, with perhaps half of the latter engaged in research With the aid of a modest increase in the recurrent grant for 1954–55 and the income from the American Counterpart Funds, it is hoped that the University of London will be able in the near future to appoint professors of applied science with special reference to engineering, soil mechanics, statistics, applied geophysics and heavy electrical engineering The new chair in heavy electrical engineering and the new readership in production engineering have been financed from sums available under the government programme for the expenditure of the Counterpart Funds, and it is expected that investment of the capital sum involved will make available about £8,000 a year The Cement Manufacturers' Association has covenanted for a second ten years to pay £2,000 a year to continue the chair of concrete technology, and some twenty-two companies are now contributing £200 a year each to the Building and Civil Engineering Contractors' Bursary Fund A number of seven-year covenants which will produce £2,300 a year have also given a new lease of life to the Nuffield Research Group in Extraction Metallurgy, apart from the permanent income of £500 a year eventually assured from the Imperial Smelting Corporation's Fund and the further £15,000 over five years provided by the Nuffield Foundation

The number of full-time students for the year under review was 1,727, compared with 1,653 in 1952–53, and, of these, postgraduate students in science and in technology numbered 223 and 349, respectively, compared with 225 and 314 in 1952–53 Of the full-time students, 111 were from foreign countries, 213 from Commonwealth countries outside the British Isles and 591 from the British Isles outside a radius of thirty miles from the College. Besides details of staff changes and the statement of accounts, a list of publications in 1953–54, arranged departmentally, is appended to the report

---

A SIMPLE METHOD FOR STUDYING AND DEMONSTRATING THE ENERGY CONSUMPTION IN FLYING INSECTS

By Dr OLAVI SOTAVALTA

Department of Zoology, University of Turku, Finland

RELATIVELY little information exists about the energy consumption in insects . what is available consists of observations on some single species of Hymenoptera, Diptera and Orthoptera only Beutler[1] gives data on sugar consumption in the honeybee, recorded on specimens in free flight in a *Flugaquarium* of glass. Wigglesworth[2] obtained energy consumption data of *Drosophila* by waxing the specimen to the head of an insect pin stuck in the cork of a glass vial, and stimulating it to flight by suddenly withdrawing the cork More or less elaborate flight-mills for studying various aspects of flight of insects, including energy consumption, have been built by several authors[3]

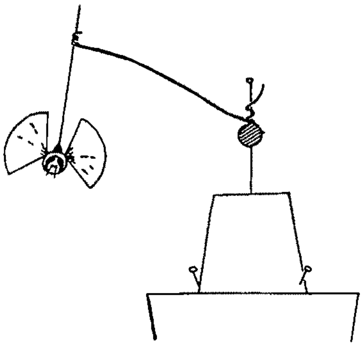


Fig 1

I have devised a method which was used for energy consumption studies on the honeybee, *Drosophila* and some other Diptera at Tufts College, Medford, Massachusetts, during 1952–53[4] It is a simplified flight-mill or 'roundabout' which consists of a metal wire of suitable length, rigidity and thickness, wound loosely by one end around an insect pin, so that it can rotate easily The pin is passed through a small ball of moulding clay to prevent the wire from falling down, and is stuck in a piece of cork (Fig 1) The other end of the wire is wound tightly around another insect pin head down, at its point end, and the insect is, under carbon dioxide or ether anæsthesia, waxed at its thorax under a binocular microscope to the head end of the pin The position of the insect in respect to the three axes of space is adjusted by bending the wire and by rotating the pin within the 'tight' wire coil In order to obtain an effective flight, the insect has to face the direction of the movement, with the long axis of the body horizontal If the body is vertical the movement may take place backwards

Insects mounted to the instrument usually start flying when the support (a piece of paper, or a cotton ball) is removed from under the tarsi If the insect refuses to start flying or stops by itself during flight, flight can be initiated easily by rotating the instrument backwards As soon as a tarsus touches an object, which may be a deliberately offered support or a part of the insect's own body, the insect stops flying

The quality of the wire and pin has naturally to conform to the size and powers of the insect Instead of waxing to the head of a pin, small insects can be conveniently glued to the uncoiled free end of the wire with a drop of 'Duco', 'Durofix' or other suitable cement, considerably thinned with acetone

This instrument is almost frictionless and easily rotated by the insect Few insects except *Drosophila* are willing to fly stationary attached to an immovable pin according to the method of Wigglesworth[2] , but a considerable number fly well in this kind of roundabout Honeybees and several other Hymenoptera are good subjects for experimenting, and flies that normally fly quietly, without sudden changes of speed, can also be used The lesser housefly (*Fannia canicularis*) is an ideal subject, while the common housefly (*Musca domestica*) and many larger flies are less satisfactory, since they generally fly in bursts and have to be stimulated to flight incessantly Once the flight has started, it can go on for hours until the insect is exhausted. While many insects consume all their energy in a relatively short time and are easy to exhaust, others have a considerable amount of reserve food in their body, and it is therefore difficult to exhaust them completely.

After a fresh insect has been flown to complete exhaustion, it is fed with a measured amount of sugar solution from a graduated micro-pipette. Standard capillary pipettes graduated in cubic millimetres can be used conveniently for larger insects, while internally waxed and calibrated pipettes of the Wigglesworth type[5] must be used for small insects. After a rest of some few minutes, the flight can be started and timed, until the insect is again completely exhausted.

The insects generally maintain a remarkable speed in the roundabout, and seven to eight revolutions per second is nothing unusual However, since the rigid wire supports the weight of the insect, all the work output is used for propulsion, and the speed observed in the roundabout therefore must not be equated with the speed of free flight of the species to be examined. [Nov 14

[1] Beutler, R , *Z vergl Physiol* , 24, 71 (1937)

[2] Wigglesworth, V B , *J Exp Biol* , 26, 150 (1949)

[3] Axenfeld, D , *Bull Accad Med Roma*, 37, 123 (1911) Krogh, A , and Weis-Fogh, T , *J Exp Biol* , 29, 211 (1952) Chadwick, L E , "Insect Physiology", ed by K D Roeder, 615 (1953) Hocking, B , *Trans Roy Ent Soc Lond* , 104, 223 (1953)

[4] Sotavalta, O , *Ann Zool Soc Vanamo*, 16, No 5 (1954)

[5] Wigglesworth, V B , *Biochem J* , 31, 1719 (1937)

RESISTIVITY IN METALS

Resistivity Changes by Plastic Deformation of Polycrystalline Metals

ANNEALED polycrystalline wires of 99 9 per cent purity copper and of 99 99 per cent purity silver, 93 mm. long and 0 5 mm in diameter, have been plastically deformed in extension and in torsion at 20° K and at 77° K , and their resistivity has been measured The apparatus used is depicted in Fig 1. Tension is applied to the specimen *F* immersed in liquid hydrogen or nitrogen through the spring *B* by moving the rod *A* upwards at a constant rate by means of a small motor. Elongation of the specimen is indicated by the pointer *C*, the force is deduced from the elongation of the spring, indicated by the pointer *D*. The wire can be twisted by means of the torsion head *E* , one complete turn corresponds to a shear strain of 0 017 at the surface The potential leads were soft-soldered to the specimen , resistivity was determined with a Diesselhorst potentiometer

First the wires were extended (to about 10 per cent), then a twist was applied (corresponding to a surface strain $\varepsilon_t \approx 0\ 1$), and afterwards the wires were extended further. In some cases a twist with subsequent extension was applied for a second time The relative variation of resistivity at the temperature of deformation as measured on several specimens has been plotted in Fig 2 Analysis of the curves yielded the following results

The extra resistivity depends on extension $\Delta l/l$ according to a power law

$$\Delta\rho_e = a(\Delta l/l)^p \qquad (1)$$

The exponent *p* differs from sample to sample. In most samples *p* lies between 1 2 and 1 4, once (copper at 77° K) *p* was found to be 1 7 The constant *a* amounts to about 0 06 μΩ cm , with a scatter of the order of 20 per cent, regardless of material or temperature Experiments by Druyvesteyn and Manintveld[1] on wires of copper, silver and gold at 77° K have yielded approximately the same results According to their observations *p* = 1 5 in all cases , *a* was comparable to our values[2]

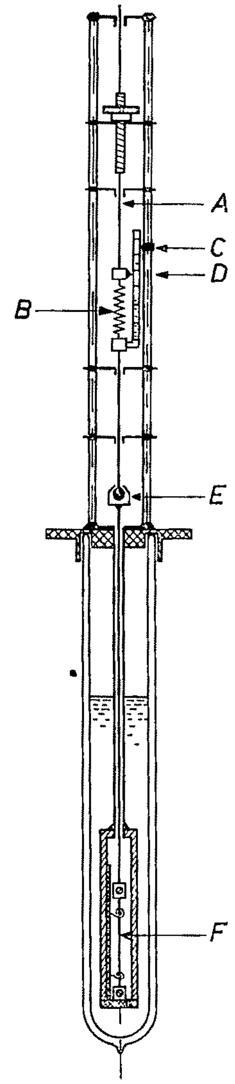


Fig 1 Schematic drawing of low-temperature deformation device

The resistivity increase on twisting is roughly proportional to the applied twist—it is about 0 04 μΩ cm at $\varepsilon_t = 0\ 1$, again, no definite dependence on material or temperature could be detected Reverse twisting has, apart from the first two or three per cent in ε_t, the same effect as direct twisting.

On subsequent extension again a power law of the form (1) is obtained, except for the first few per cent of strain The exponent *p* has remained remarkably constant , only the coefficient *a* has become greater by a 'multiplication' factor *m* which increases with the twist, and is about 1 3 for $\varepsilon_t = 0\ 1$, regardless of material or temperature

The extra resistivity of a plastically deformed metal must be attributed to dislocations or to point defects (vacancies and interstitials) or to both Assuming the dislocations to be formed by Frank-Read sources and the point defects by the effect of intersection of dislocation loops with dislocations already present in the material, the existence of a power law with exponent slightly greater than 1 can be shown to be in good agreement with the idea that point defects contribute to most of the resistivity rather than dislocations[2,3]. The dislocation density in the material after 10 per cent extension being certainly not higher than 10^{11} cm $^{-2}$, their influence on the resistivity should, according to calculations by Hunter and Nabarro[4], be less than $10^{11} \times 0\ 4 \times 10^{-14}$ μΩ cm $= 4 \times 10^{-4}$ μΩ cm in copper, while 3×10^{-3} μΩ cm was observed The density o point defects formed, taking d_0, the density o dislocations originally present, to be 10^8 cm $^{-2}$, i found, after 10 per cent extension, to be abou 10^{18} cm $^{-3}$. The resistivity increase by vacancies i copper was computed by Jongenburger[5] as 1 3 μΩ cm./per cent vacancies , that caused by interstitials is probably somewhat larger (see following com munication), namely, 5 μΩ cm./per cent inter stitials. Taking 3 μΩ cm /per cent defects as a mean value, the concentration mentioned of defects

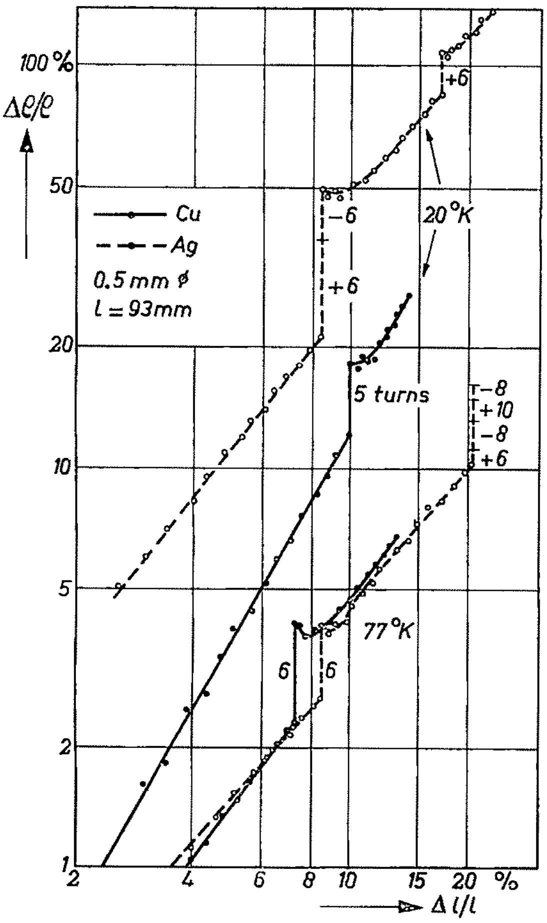


Fig 2 Relative increase of resistivity $\Delta\rho/\rho$ as a function of extension $\Delta l/l$ and of twist (expressed in the number of complete turns of the torsion head) for copper (full curves) and silver (dashed curves) wires A minus sign of the twist refers to reverse twisting

accounts for 0 003 $\mu\Omega$ cm. of the extra resistivity, which is in agreement with the observation

The results of the combined twisting and extension experiments seem to confirm these conclusions. A surface strain of 0 1 of the wire corresponds to the introduction of 1 3 $\times 10^8$ new dislocations per cm.[2] Their influence on the resistivity is, according to Hunter and Nabarro, only 0 5 $\times 10^{-6}$ $\mu\Omega$ cm, as compared to the observed increase of 0 004 $\mu\Omega$ cm. By the process of intersecting dislocations, point defects are also formed From the dimensions of the specimen and the applied twist, it is found that the number of defects formed is 5 $\times 10^{17}$ cm^{-3} at ε_t = 0 1, this results in an increase of resistivity of 0 002 $\mu\Omega$ cm, which is in much better agreement with observations

The occurrence of the multiplication factor m, rather than an additive effect on resistivity alone which remains constant on further extension, also points to the effect of point defects on resistivity as being by far the most important one The introduction of new dislocations, homogeneously distributed and of predominantly screw character, increases the rate at which expanding loops around Frank–Read sources form point defects in the ratio new density of crossing dislocations to old density d_0 (before the twist). However, the action of the sources is slightly impeded by the increase in dislocation density, and it can be shown[3] that one can put approximately $m = (d/d_0)^{3/4}$. From the observed value of m and the known number of newly introduced dislocations, d_0 can be computed It is found that $d_0 = 3 \times 10^8$ cm^{-2}, a reasonable value in view of the uncertainties of the theory.

The conclusion that point defects can be held responsible for nearly all the resistivity increase caused by plastic deformation of polycrystalline metals, and that the direct effect of dislocations plays only a minor part in this respect, seems, from the results of the experiments, to be warranted.

H. G VAN BUEREN
P JONGENBURGER

Philips Research Laboratories,
N.V Philips' Gloeilampenfabrieken,
Eindhoven, Netherlands

[1] Druyvesteyn, M J, and Manintveld, J A, *Nature*, 168, 868 (1951) Manintveld, J A, *Nature*, 169, 623 (1952)

[2] van Bueren, H G, *Acta Metal*, 1, 464, 607 (1953)

[3] van Bueren, H G, *Acta Metal* (to be published)

[4] Hunter, S C, and Nabarro, F R N, *Proc Roy Soc*, A, 220, 542 (1953)

[5] Jongenburger, P, *Appl Sci Res*, B, 3, 237 (1953)

Extra-Resistivity due to Interstitial Atoms in Copper

SOME time ago we performed calculations on the extra-resistivity due to vacancies in copper, silver and gold[1]. When we tried to extend our calculations to the case of interstitials, this turned out to be much more complicated. Therefore, only a very rough estimation will be presented here, concerning copper

Theoretical arguments can be raised against the method used, but it finds some justification in the fact that it gives results of the correct order of magnitude in some cases, as will be shown below

Scattering of the conduction-electrons is caused by (*a*) the interstitial atom itself, and (*b*) the displacements of the neighbouring atoms The extra-resistivities due to these causes are supposed to be additive The free-electron approximation is used

(*a*) We represent the interstitial atom by a rectangular attractive field with radius a and depth U_0 As in the case of vacancies, we adjust U_0 in such a way that the asymptotic phase shifts α_l obey Friedel's[2] equation $\sum_l (2l + 1)\alpha_l = \pi/2$ Unfortunately, when performing this calculation for a number of a's, it turns out that the scattering area A varies much more with a than in the case of vacancies (Fig. 1) Taking a equal to r_s we find, but with a much greater uncertainty than in the case of vacancies, $\rho_a \sim$ 1 – 2 $\mu\Omega$ cm /per cent interstitials In passing, we remark that the use of an effective electron mass m^* instead of the free electron mass m gives essentially the same result if U_0 is again adjusted in the way indicated.

(*b*) The displacements of the neighbouring atoms were calculated by Huntington[3] In his configuration B we have 6 atoms with a displacement of 0 40 A and 24 atoms with a displacement of 0 13 A From this we find the mean of the square of the x-component of displacement for 1 per cent of interstitials in the following way

$$\overline{\delta^2{}_x} = \frac{1}{3}\,\frac{6 \times (0\ 40)^2 + 24 \times (0\ 13)^2}{100} = 0\ 0046\ \text{A}^2$$

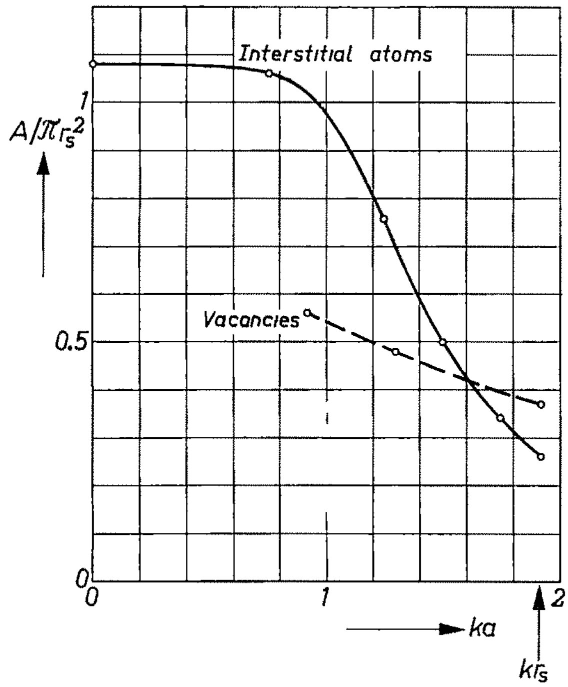


Fig. 1

The displacement of the copper atoms due to thermal motion at room-temperature is given by $\overline{\delta^2_{Tx}}$ = 0·0022 A². So the extra-resistivity due to the displacement of neighbours is estimated to be

$$\rho_d = \frac{0{\cdot}0046}{0{\cdot}0022}\, 1{\cdot}67 = 3{\cdot}5\ \mu\Omega \text{ cm./per cent interstitials}$$

Of course, this estimation is very crude, as the displacements due to the presence of an interstitial atom are not correlated with each other in the same way as the displacements due to thermal motion. But as the thermal resistivity itself can be estimated rather well without taking into account any correlation between the positions of the atoms[4], also in this case the order of magnitude will probably be correct. Moreover, the method works rather well in the case of a solid solution of carbon in iron. As is well known, this is an interstitial solution, the carbon atom being placed in the middle of the edges of the body-centred cubic cell. We assume that only the two nearest iron atoms are displaced, and that the extra-resistivity is only (or mainly) caused by these displacements, the carbon atom being neutral. Then from the observed extra-resistivity[5], following the method presented before, we find that the two nearest iron atoms are displaced 0·4 A. each. This is a reasonable value, the radius of the available site being 0·2 A. and of a carbon atom 0·8 A.

The extra-resistivity due to edge-dislocations can also be estimated on these lines; we find about the same value as Hunter and Nabarro[6].

We conclude, therefore, that also in our case we have made a reasonable estimation of the extra-resistivity due to the displacements; our result, however, is in striking disagreement with the calculations of Dexter[7], who concludes that the contribution of the displacements to the resistivity can be neglected. The cause of this discrepancy is not understood at present, but is probably caused by the transformation of his eq. (9) to (9′), which causes the scattering potential to be smeared out, thus lowering the resistivity considerably.

From (*a*) and (*b*) we conclude that the extra-resistivity due to interstitials is about 5 μΩ cm./per cent interstitials.

The fact that interstitial atoms have a much larger influence on the resistivity than vacancies (1·3 μΩ cm./per cent) is at least qualitatively confirmed by Overhauser's stored-energy measurements in irradiated copper[8], which gave a value of about 10 μΩ cm./per cent interstitials.

P. JONGENBURGER

Philips Research Laboratories,
N.V. Philips' Gloeilampenfabrieken,
Eindhoven, Netherlands.

---

[1] Jongenburger, P., *Appl. Sci. Res.*, B, 3, 237 (1953); *Phys. Rev.*, 90, 710 (1953).

[2] Friedel, J., *Phil. Mag.*, 43, 153 (1952).

[3] Huntington, H. B., *Phys. Rev.*, 91, 1092 (1953).

[4] Kittel, Ch., "Introduction to Solid State Physics", p. 264 (Wiley, 1953).

[5] Dijkstra, L. J., *Philips Res. Rep.*, 2, 357 (1947).

[6] Hunter, S. C., and Nabarro, F. R. N., *Proc. Roy. Soc.*, A, 220, 542 (1953).

[7] Dexter, D. L., *Phys. Rev.*, 87, 768 (1952).

[8] Overhauser, A. W., *Phys. Rev.*, 94, 1551 (1954).

INDUCTION PERIODS AND IGNITION LIMITS IN SENSITIZED IGNITIONS OF HYDROGEN AND OXYGEN

By PROF. R. G. W. NORRISH, F.R.S., and
DR. P. G. ASHMORE
Department of Physical Chemistry, University of Cambridge
AND
PROF. F. S. DAINTON
School of Chemistry, University of Leeds

THE work of Hinshelwood and Thompson[1] upon the effect of nitrogen dioxide on the thermal reaction between hydrogen and oxygen was extended by Griffiths and Norrish[2] and by Foord and Norrish[3]. The success of Semenoff's treatment[4] of branched-chain reactions led Foord and Norrish to assume that the sensitized reaction is a simple branched-chain reaction and that the induction period (τ) is the time for the concentration of the chain centres (n) to reach a critical value (n_c). Hence, provided the net branching factor (φ) and the rate of initiation (θ) do not vary during the induction period, the expression for the latter is

$$\tau = \frac{1}{\varphi}\ln\left(1 + \frac{\varphi}{\theta}n_c\right) \qquad (1)$$

Also, it was frequently assumed that θ and φ are so related that variations in the logarithmic term are small, and τ was therefore regarded as being approximately inversely proportional to φ. This relation between τ and φ was used to make deductions about the properties of φ from the observed dependence of τ on certain experimental variables, and, when combined with the notion that explosion occurs when φ exceeds a critical value (φ_c) determined by the thermal capacity and the conductivity of the system, formed the basis of a reasonably satisfactory explanation of the main features of the sensitized ignitions with nitrogen dioxide[3,5] and with nitrosyl chloride[5].

However, it was recognized that two results frequently obtained by different observers[5,6] are at variance with this theory With constant pressures of hydrogen and oxygen, when φ_c is constant, it was found that (1) the value of τ at the higher sensitizer limit of ignition often exceeds the value at the lower limit, and (2) at low sensitizer concentrations τ frequently increases as the sensitizer concentration is increased and the system passes from a region of slow reaction to one of ignition If the relation $\tau\varphi$ equal to a constant is applied to these observations, then it must be concluded (1) that φ can have different values at the two limits, and (2) that φ can decrease in passing from slow reaction to ignition. The unsatisfactory nature of these conclusions needs no emphasis

The purpose of this communication is to indicate how these difficulties may be resolved by regarding the induction period as the time during which φ is progressively increasing, while retaining the condition that, if φ exceeds a critical value, explosion results The increase is brought about by the decomposition of the additive, which functions principally as a chain terminator, to yield nitric oxide, as the decomposition occurs partly by reaction of the additive with chain centres, and the nitric oxide can start fresh chains, there is a delayed chain branching. The view that "nitric oxide is the true catalyst . . whilst nitrogen peroxide is an inhibitor . . " was first adopted by Griffiths and Norrish[2] Because φ is changing during the induction period, equation (i) is now considered invalid.

The experimental evidence (Ashmore, *Trans Farad Soc*, in the press) for this view will be briefly summarized.

(i) In the same vessel at any particular temperature, the lower and upper limits of sensitizer for ignition are the same whether the original additive is nitrosyl chloride, chloropicrin, nitrogen dioxide, or a mixture of nitrogen dioxide and nitric oxide

(ii) On the other hand, the induction periods are shorter the more readily the original additive decomposes. For equimolar amounts of additive, the induction period with chloropicrin is less than that with nitrosyl chloride, which in turn is less than that with nitrogen dioxide

(iii) When the additive is placed in the reaction vessel before the reactants (rapid mixing being ensured, see Ashmore and Chanmugam[7]) the induction periods are shorter the longer the additive has been in the vessel, and they can become zero

(iv) If nitric oxide is introduced first into the reaction vessel, and the reactants added, instantaneous ignitions occur if the nitric oxide concentration is above a value which diminishes as the concentrations of the reactants are increased, however, there is no upper limit If a little nitrosyl chloride or nitrogen dioxide is mixed with the reactants, the upper limit reappears.

(v) When reactants containing nitrogen dioxide are added to a reaction vessel containing nitric oxide, keeping the total number of moles, nitric oxide + nitrogen dioxide, constant, there is a marked and regular decrease in the induction periods as the proportion of nitric oxide in the reaction vessel is increased This occurs throughout the ignition region and just above the upper limit.

(vi) There is now clear evidence from photometric work in progress at Cambridge that nitrogen dioxide disappears during the induction period for mixtures of hydrogen, oxygen and nitrogen dioxide admitted in the normal manner The concentration of nitrogen dioxide just before ignition is smaller the larger the initial concentration of nitrogen dioxide Near the upper limit, less than 5 per cent usually remains.

A kinetic scheme has been developed which includes the following reactions in addition to those believed to occur in the unsensitized hydrogen–oxygen reaction and in the molecular decompositions of chloropicrin, nitrosyl chloride, and nitrogen dioxide

$$H + NO_2 \rightarrow NO + OH \tag{1}$$

$$NO + O_2 \rightarrow NO_2 + O \tag{2}$$

$$O + NO_2 \rightarrow NO + O_2 \tag{3}$$

$$OH + NO_2 + M \rightarrow HNO_3 + M \tag{4}$$

$$H + NOCl \rightarrow NO + HCl \tag{4a}$$

$$HO_2 + NO \rightarrow NO_2 + OH \tag{5}$$

Hydrogen atoms from the main chain reduce nitrogen dioxide to nitric oxide by reaction (1), and in so doing produce the main-chain carrier OH The main chain is thus continued In addition, the nitric oxide generates an oxygen atom in reaction (2), and when this atom is not destroyed but reacts with molecular hydrogen, additional chains are started and therefore the rate of chain branching has been augmented Nitric oxide also increases φ by converting HO_2 radicals (which at the temperature concerned are not chain carriers but probably diffuse to, and are destroyed at, the wall) into hydroxyl radicals The additives themselves are chain terminators by virtue of reactions such as (4) and (4*a*) It is interesting to note that in all the reactions mentioned the integrity of the NO group is preserved. The remarkable effects of nitrogen dioxide and of nitrosyl chloride are due to the high dissociation energy of N—O and the relatively low dissociation energies of ON—O and ON—Cl.

An expression for the net branching factor φ has been derived, and its variation with concentration of nitric oxide and nitrogen dioxide studied If the condition for ignition is assumed to be that, whatever temporal changes φ undergoes during the induction period it does not attain the critical value φ_c (which may be zero or positive) until the end of the induction period, then the predicted changes in the induction periods and in the ignition limits are in very satisfactory qualitative agreement with those found experimentally for appropriate conditions of reactant pressure, pressure of additive, inert gas pressure and irradiation It seems likely that some quantitative relationships will follow from the photometric studies now in progress In the meantime, the evidence for the destruction of the additive as the cause of the induction period and for the absence of any simple connexion between φ and τ in these sensitized ignitions seems very strong [Jan 22

[1] Hinshelwood, C N, and Thompson, H W, *Proc Roy Soc*, A, 124, 219 (1929)

[2] Griffiths, J G A, and Norrish, R G W, *Proc Roy Soc*, A, 139, 147 (1933)

[3] Foord, S G, and Norrish, R G W, *Proc Roy Soc*, A, 152, 196 (1935)

[4] Semenoff, N, "Chemical Kinetics and Chain Reactions" (Oxford, 1935)

[5] Dainton, F S and Norrish, R G W, *Proc Roy Soc*, A, 177, 421 (1941)

[6] Ashmore, P G, and Norrish R G W, *Proc Roy Soc*, A, 203 454 (1950)

[7] Ashmore, P G, and Chanmugam, J, *Nature*, 170, 1067 (1952)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cephalosporin C, a New Antibiotic containing Sulphur and D-α-Aminoadipic Acid

A SPECIES of *Cephalosporium* produces a hydrophilic penicillin, called cephalosporin *N*, which yields D-α-aminoadipic acid on hydrolysis[1]. Crude preparations of cephalosporin *N* have been found to show strong absorption in ultra-violet light at 260 mμ, although highly purified cephalosporin *N* shows very little absorption at this wave-length A new antibiotic with an absorption maximum at 260 mμ has now been isolated from the crude preparations in the form of a crystalline sodium salt It resembles cephalosporin *N* in certain physical, chemical and biological properties, but differs from it sharply in others

Cephalosporin *C* sodium salt ($[\alpha]^{20}_{D}$ + 103° , λ_{max} 260 mμ, ε_{max} 9,500) separates from aqueous ethanol or aqueous propanol in monoclinic crystals Its equivalent weight, determined by titration, is 480 ± 15 X-ray crystallographic measurements were kindly made by Dr Dorothy Hodgkin and Mrs. M Mackay, who reported as follows unit cell dimensions $a = 13\ 12$ A , $b = 4\ 97$ A , $c = 17\ 82$ A , $\beta = 106° \ 30'$ Space group, $P2_1$, number of molecules in the unit cell, 2 , density, 1 38 The molecular weight, calculated from these figures, is 470 ± 15

On drying *in vacuo* at room temperature, cephalosporin *C* sodium salt loses two moles of water which are rapidly regained on exposure to laboratory air. The results of elementary analysis, together with the value for the molecular weight, indicate that a possible molecular formula for the crystalline hydrate is $C_{16}H_{20}O_8N_3SNa,2H_2O$, but this formula is only a provisional one and may need revision.

The infra-red spectrum of cephalosporin *C* sodium salt (in paraffin paste) shows bands at the following wave-lengths 2 94μ, 3 06μ. 5 61μ, 5 77μ, 6 05μ, 6 29μ, 6 57μ, 7 17μ and 7 36μ. It is of interest that a band in the region of 5 61μ is shown by the common penicillins and by cephalosporin *N*, and has been attributed in the former to the C=O of the fused β-lactam-thiazolidine ring system[2] The band at 5 77μ could be due to an ester or lactone grouping.

Cephalosporin *C* gives a ninhydrin reaction Electrometric titration indicates that it is a mono-aminodicarboxylic acid, having two acidic groups with *p*K values of 3 1 and <2 6 respectively and a basic group with a *p*K value of 9 8 When subjected to ionophoresis on paper in a collidine–acetate buffer at *p*H 7, it migrates towards the anode at almost the same rate as cephalosporin *N*

Unlike cephalosporin *N* and benzylpenicillin, cephalosporin *C* is stable in aqueous solution at *p*H 2 5 at room temperature It is rapidly inactivated, however, with loss of its characteristic absorption spectrum, at *p*H 12 After it has been kept in aqueous solution at *p*H 12 for two hours, back titration shows that two acidic groups per mole have been formed. Under similar conditions only one acidic group is liberated from cephalosporin *N* and benzylpenicillin

Cephalosporin *C* is not inactivated by penicillinase from *B. subtilis*, strain 569 [3]. It loses activity, though much less rapidly than cephalosporin *N* or benzylpenicillin, in the presence of a crude preparation of
penicillinase from *B cereus* (*NRRL* 569) The i
activation is accompanied by the liberation of a
acidic group and loss of absorption at 260 mμ I
appears to be caused by an enzyme other tha
penicillinase which is present in the preparation. Th
ratio (cephalosporinase activity/penicillinase activity
was much lower with highly purified penicillinase
from *B cereus* than with the crude material.

On hydrolysis with acid, cephalosporin *C*, lik
cephalosporin *N*, yields one mole of carbon dioxid
and D-α-aminoadipic acid The product obtained b
allowing cephalosporin *C* to react with 1 2 4-fluoro
dinitrobenzene yields, on hydrolysis, a substanc
which behaves like dinitrophenyl-α-aminoadipic ac
on paper chromatograms. It therefore appears tha
cephalosporin *C* contains a residue of D-α-aminoadip
acid and that the α-amino group is free The *p*K valu
of this group suggests that the α-carboxyl group
also free

Hydrolysis of cephalosporin *C* with acid yiel
little, if any, penicillamine However, the carbo
skeleton of penicillamine appears to be present
the molecule Hydrolysis of the product obtaine
from cephalosporin *C* by hydrogenolysis with Rane
nickel yields, in addition to α-aminoadipic acid, a
amino-acid which behaves like valine on pape
chromatograms

Cephalosporin *C* is less active than cephalosporin
against most of the bacteria tested, although the tw
compounds show similar activities against a stra
of *Bact coli* Against *Staph aureus* and *Salm. typh*
cephalosporin *C* shows an activity[5] of 8–10 uni
per mgm

In 1951 a strain of *Cephalosporium* isolated in th
United States was reported to produce an antibiot
called synnematin[6]. Abraham, Newton, Crawfor
Burton and Hale[7] directed attention to the possibili
that synnematin was identical with cephalosporin *N*
Synnematin was later separated into two componen
called synnematin *A* and synnematin *B*, the form
being apparently less soluble in methanol than th
latter[8] The behaviour of crude synnematin *B* o
paper chromatograms buffered with sodium citrat
*p*H 5 5, and run with methanol[6] appears to be ver
similar to that of cephalosporin *N* ($R_F = 0\ 44$
However, the reported behaviour of crude synnemat
A under these conditions ($R_F = 0$) is different fro
that of cephalosporin *C* ($R_F = 0\ 34$)

We are grateful to the Distillers Company (Bi
chemicals), Ltd , and to Dr. M R Pollock for gif
of penicillinase

G. G F NEWTON
E. P ABRAHAM

Sir William Dunn School of Pathology,
University of Oxford
Feb 3

---

[1] Newton, G G F , and Abraham, E P , *Nature*, 172, 395 (1953
Biochem J , 58, 103 (1954)

[2] Thompson, H W , Brattain, R R , Randall, H M , and Rasmusse
R S , "The Chemistry of Penicillin", chapter 13 (Princet
University Press, 1949)

[3] Manson, E E D , Pollock, M R , and Tridgell, E J , *J Gen Mic
biol* , 11, 493 (1954)

[4] Pollock, M R , and Torriani, Anne-Marie, *C R Acad Sci , Par*
237, 276 (1953)

[5] Abraham, E P , Newton, G G F , and Hale, C W , *Biochem*
58, 94 (1954)

[6] Gottshall, R Y , Roberts, J M , Portwood, L M , and Jennin
J C , *Proc Soc Exp Biol Med* , 76, 307 (1951)

[7] Abraham, E P , Newton, G G F , Crawford, K , Burton, H
and Hale, C W , *Nature*, 171, 343 (1953)

[8] Olson, B H , Jennings, J C , and Junek, A J , *Science*, 117,
(1953) Olson, B H , Jennings, J C Pisano, M , and June
A J , *Antibiotics and Chemotherapy*, 4, 1 (1954)

An Infectious Nucleoprotein from Tobacco Mosaic Virus

WE have reported previously the degradation of tobacco mosaic virus in alkaline solution into a series of sub-units, of which the molecular weights could be determined in the ultracentrifuge. By reaggregation of these sub-units, we obtained a protein that had the same size and shape as the virus itself, but was not infectious[1]. Recently the process of degradation has been studied exhaustively by fractionating the products by electrophoresis. We carried out many experiments, varying the *p*H, the time of degradation and the temperature. We mention here only one ypical pattern obtained three hours after adjusting he *p*H to 10·3 at 0° C., which is reproduced in Fig. 1; t shows five different boundaries, of which Nu has he highest and IV the lowest mobility. Each fraction was isolated for study; the results are listed in Table 1.

Table 1. ELECTROPHORETICAL FRACTIONS OF TOBACCO MOSAIC VIRUS. 3 hr., *p*H 10·3, 0° C.

Fractions	Nu	I	II	III	IV	TMV
Mobility, ascending	−15·6	−12·7	−10·2	−9·2	−5·5	−9·2
Ribonucleic acid (per cent)	90	15	9	6	0	6
s_{20} in S, $c=0·4$ per cent	4·2	80–160		80–180	4·6	180
Infectivity	—	—	+	+	—	+

Fraction I contains 90 per cent ribonucleic acid nd 10 per cent protein. The sedimentation contant indicates a high molecular weight. Electronmicrographs show that the ribonucleic acid has a lamentous shape (Fig. 3). Fractions I and II conain more ribonucleic acid than the original virus. n the ultracentrifuge we found several definite comonents, which had smaller sedimentation constants han the original virus. Fraction III is identical with the original virus with regard to ribonucleic cid content, mobility and sedimentation constant, ut in the ultracentrifuge a small amount of material f lower molecular weight was also observed. Fraction V is a protein free of ribonucleic acid with a molecular weight of about 100,000. It is identical in all s properties with a natural by-product of virus reproduction that we isolated from virus-infected tobacco plants by the method of Takahashi[2]; in articular, we obtained the same intermediates and nal products in the reaggregation.

After prolonged exposure to *p*H 10·3, the nucleoroteins I and II were converted into ribonucleic cid and protein (IV). Fractions I and II may thereore be termed the 'labile fraction'. Surprisingly, fraction III does not disintegrate to protein and ribonucleic acid even after months at *p*H 10·5. It is therefore termed the 'stable fraction'. In different preparations of normal tobacco mosaic virus we always found the same proportion (30 per cent) of the stable fraction; but in a preparation of the Dahlemense strain the amount was significantly lower (12 per cent).

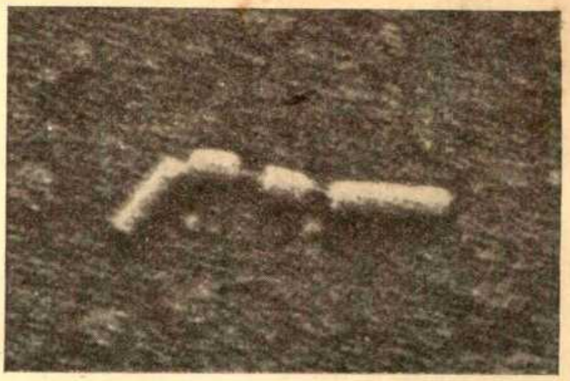


Fig. 2. Tobacco mosaic virus particles with gaps from fractions I+II. × 150,000

In the initial phase of the degradation the labile fraction and the stable fraction are both highly infectious in the local-lesion test with *Nicotiana glutinosa* and *Phaseolus*, whereas Nu and fraction IV are not infectious. After prolonged treatment, all components become inactive. By centrifugation of fractions I+II at 25,000 r./min. a fraction of high molecular weight was separated which had nearly the same infectivity per mgm. protein-nitrogen as the original virus. Since the ribonucleic acid content, the sedimentation constant, and the mobility show that this material is quite distinct from tobacco mosaic virus, we probably have for the first time a biologically active degradation product of the virus.

At the very beginning of the degradation protein appeared, but no ribonucleic acid. It is therefore probable that fractions I+II are formed from the tobacco mosaic virus by loss of protein, so that the ribonucleic acid content is higher than that of tobacco mosaic virus, a conclusion that is confirmed by the electronmicrograph. In fractions I+II we observed rods of tobacco mosaic virus with gaps, where only a thin filament, probably of ribonucleic acid, is to be seen (Fig. 2). Filaments of the same diameter can be seen on Fig. 3, where some rods are totally disintegrated to ribonucleic acid and disks of protein having the same diameter as the rods, a thickness of about 70 A., and a hole in the centre. We suggest that in the virus these disks are strung on a thread of ribonucleic acid. From the electronmicrographs we estimate the diameter of the filaments to be 30–40 A. at the most. If all the ribonucleic acid were concentrated in one strand of the same length as tobacco mosaic virus, the diameter would also be 30 A. The increased mobility of fractions I+II may be caused by the loss of protein, though other explanations are possible; but it cannot be due to the adsorption of ribonucleic acid on the intact virus particles, as we have been able to

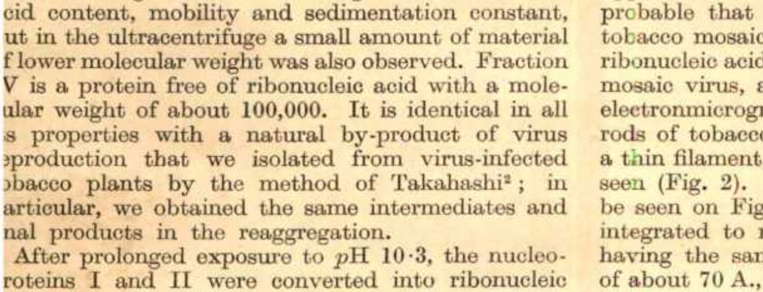


Fig. 1. Electrophoresis of disintegrated tobacco mosaic virus, descending boundary

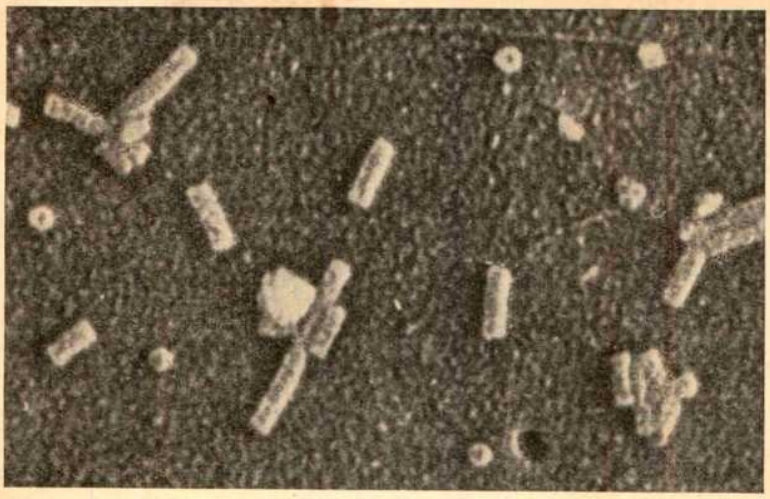


Fig. 3. Fragments of tobacco mosaic virus, filaments of ribonucleic acid and protein disks with a hole. × 150,000

prove by electrophoresis of a mixture of ribonucleic acid and tobacco mosaic virus.

A more detailed report of this work will be published in the *Zeitschrift für Naturforschung*.

G. Schramm
G. Schumacher
W. Zillig

Max-Planck-Institut für Virusforschung,
Tübingen.
Nov. 15.

[1] Schramm, G., *Z.Naturforsch.*, **2b**, 112 and 249 (1947); "Adv. Enzym.", **15**, 449 (1954).

[2] Takahashi, W., and Ishii, M., *Amer. J. Bot.*, **40**, 85 (1953).

Cellular Control in Virus Infection

Marked changes may be produced by virus infection in a host cell when the amount of virus material is very small compared with the amount of host cell and when some of the host's synthetic activities are altered by the presence of the virus. Many authors refer to this control of the cell by the infecting particle; but experimental evidence is very scanty. In infection by coliphage T_2, Cohen[1] has shown that infected cells use an alternative metabolic pathway to a greater extent than do normal cells. No definite information is available in mammalian virus infections as to the presence of such metabolic alterations, nor the means by which such changes could be produced.

In mouse liver infected with ectromelia virus at initial infecting levels of about 1 *LD* 50 per liver cell, the infectious titre drops to less than 1 per cent of the initial level and then returns to the initial titre at about 11 hr. The titre remains stationary until about 22 hr., when an increase of some thirty-fold occurs. It was suggested recently[2] that the eclipse period was concerned with establishing control of the cell before multiplication occurred. Evidence which supports this suggestion has been obtained by studying the effect of this virus on regenerating liver. It was found that at the same stage of regeneration there was a lower mitosis-rate in livers of mice infected 12 hr. previously than in livers of uninfected mice. For example, in young mice examined 40 hr. after partial hepatectomy, an uninfected group had a mitosis-rate of 6·7 ± 0·6, whereas a group infected for 12 hr. had an average mitosis-rate of 1·4 ± 0·3. Mice infected for longer periods show a more marked effect, mitosis being rare after 20 hr. of infection. In the first 12 hr. of infection, we have been unable to detect any abnormality in morphology or composition of liver, or any alteration in oxygen uptake, fructose utilization, or lactic acid production. The infectivity titre shows no virus multiplication at this time, and stays unaltered until about 22 hr. Complement-fixing antigen rises to detectable level at 12–14 hr. and increases in roughly linear fashion. Results of preliminary experiments show that the deoxyribonucleic acid per nucleus is the same in infected and non-infected cells at the same period of regeneration.

The control of mitosis appears at an early stage of infection, and is established at the end of the eclipse period, which appears to be the onset of time of multiplication of virus material. The time sequence suggests that the effect on mitosis may be closely related to the essential primary effect of the virus on the cell. The lack of other changes found in the liver after 12 hr. of infection makes the phenomenon less likely to be a secondary change, though they provide no lead as to the biochemical basis.

A further indication of disturbance of normal control is found later in the growth-cycle. In intact livers studied 30–40 hr. after infection, there is an increase in the amount of cytoplasmic material far greater than can be accounted for by virus. There is an increase in the ratio of cytoplasmic to nuclear volume and in the amount of protein per liver, without any increase in the amount of deoxyribonucleic acid. There is no increase in the number of cells.

As a working hypothesis, we consider that the alteration in cellular economy necessary for virus production, first indicated by control of mitosis, leads to the production of more cytoplasm, and this abnormal form of growth is followed by damage to the cell. Cellular damage is regarded, however, as a by-product of, rather than a prerequisite for, virus multiplication.

P. M. de Burgh
J. F. A. P. Miller

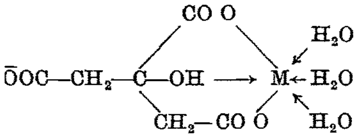
Department of Bacteriology.
University of Sydney.
Nov. 24.

[1] Cohen, S. S., *Nature*, **168**, 746 (1951).

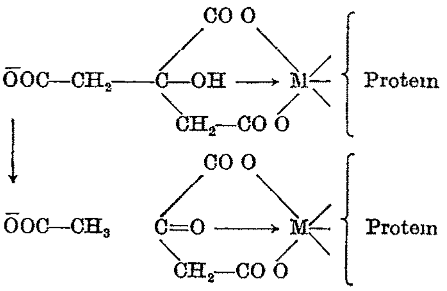
[2] Nossal, G. J. V., and de Burgh, P. M., *J. Gen. Microbiol.*, **10**, 345 (1954).

A Mechanism for Citrate Dissimilation

Certain bacteria dissimilate citrate anaerobically to acetate and oxaloacetate[1-4]; the reaction is of particular interest since, unlike citrate biosynthesis, it is not dependent on coenzyme A[1,2]. We have partially purified extracts of *A. aerogenes* and have demonstrated the following properties of citridesmolase: (1) As the reaction proceeds, the enzyme is progressively inactivated and ceases to function with citrate in excess. The amount of citrate decomposed is proportional to the amount of enzyme present (2) Oxaloacetate inhibits the reaction powerfully Acetate and pyruvate (a product of the action of crude preparations) do not (3) The enzyme is activated by certain divalent ions, notably magnesium, zinc and ferrous iron (4) Calcium ions do not activate, but they inhibit the action of magnesium ions competitively. Bobtelsky and Jordan[5] proposed the structure (I) for chelate compounds between certain divalent metal ions and citrate, and they demonstrated that the hydrogen atom of the coordinated hydroxyl group was labile On this basis a mechanism for citrate dissimilation by the enzyme is suggested (II)



(I)



(II)

The mechanism would account for the role of divalent metal ions in activation and competitive inhibition, and if there is a tendency for oxaloacetate to remain on the active site as shown, it would explain the observed inhibition by this product of reaction and the progressive inactivation that occurs. The asymmetric decomposition of the citrate molecule is a consequence of its three-point attachment It has been suggested[6] that a chelate compound involving ferrous iron and citrate participates in the aconitase system

We acknowledge assistance given by Mr J Sykes and Mr R G Stickland at a stage in this work.

S Dagley

University of Leeds

E A Dawes

University of Glasgow
Nov 25

Dagley, S , and Dawes, E A , *Nature*, 172, 345 (1953)
Gillespie, D C , and Gunsalus, I C , *Bact Proc* , 80 (1953)
Grunberg-Manago, M , and Gunsalus, I C , *Bact Proc* , 73 (1953)
Dagley, S , *J Gen Microbiol* , 11, 218 (1954)
Bobtelsky, M , and Jordan, J J , *J Amer Chem Soc* , 67, 1824 (1945)
Dickman, S R , and Cloutier, A A , *J Biol Chem* , 188, 379 (1951)

Production of Pyruvate from 6-Phosphogluconate by Bacterial Plant Pathogens and Legume Bacteria

In the course of investigations on the metabolism of phytopathogenic and root-nodule bacteria, it was observed that certain species of the former, and all species tested of the latter group of organisms, produced pyruvate from 6-phosphogluconate, and from glucose-6-phosphate plus triphosphopyridine nucleotide Accompanying the formation of pyruvate was the appearance of triose phosphate These results suggested that the 6-phosphogluconate was being metabolized in a manner similar to that reported recently with *Pseudomonas saccharophila* by Entner and Duodoroff[1] and MacGee and Duodoroff[2], and with *P fluorescens* by Wood and co-workers[3] These observations were confirmed by the fact that the intermediate in this pathway, 2-keto,3-deoxy,6-phosphogluconate (kindly supplied by Dr MacGee, of the University of California, Berkeley, Calif) was also split by cell-free extracts of our cultures to pyruvate and triose phosphate

In these experiments cultures were grown in a fluid medium containing 1 per cent yeast extract and 2 per cent glucose in Fernbach flasks on a rotary shaker at 26° C The cells were harvested after 20 hr , washed twice in tap water and suspended in four times their wet weight in distilled water They were then subjected to sonic vibration in a Raytheon oscillator (10 kc /sec) for 5–10 min and the debris removed by centrifugation at 10,000 r p m for 10 min Pyruvate was determined either by the direct or by the double extraction methods of Friedmann and Haugen[4] and was further identified as the hydrazone by descending paper chromatography in a butanol–ammonia solvent, as described by Cavallini *et al.*[5] Triose phosphate was determined as alkali-labile phosphorus[6] Protein was estimated by means of the Folin phenol reagent as outlined by Lowry *et al* [7]

Representative species of the major groups of plant pathogenic bacteria were tested *Xanthomonas*, *Pseudomonas*, *Agrobacterium*, *Corynebacterium* and *Erwinia* All species of the first three genera were capable of carrying out the above reaction *Agrobacterium radiobacter* also gave a positive result. None of the species of *Corynebacterium* or *Erwinia* used (*C fascians*, *C flaccumfaciens*, *C. michiganense*, *E carotovora*, *E amylovora*) was found to split 6-phosphogluconate in this manner All species of *Rhizobium* studied (*R leguminosarum*, *R. trifolii*, *R meliloti* and *R phaseoli*) produced pyruvate from 6-phosphogluconate A summary of the results obtained with certain of the bacterial species tested is given in Table 1

Table 1 Production of Pyruvate from 6-Phosphogluconate
The reaction mixture contained 0 1 ml tris(hydroxymethylamino-methane) buffer *M*/1, *p*H 7 7, 0 1 ml *M*/20 6-phosphogluconate, 0 1 or 0 2 ml sonate, water to 1 ml , it was incubated at 35° C for 30 min and the reaction stopped by addition of 1 ml of a 0 1 per cent solution of 2,4-dinitrophenylhydrazine in 2 *N* hydrochloric acid

Organism	Pyruvate (*μM* per 10 mgm protein)
Xanthomonas phaseoli	4 0
Pseudomonas angulata	4 2
Agrobacterium rubi	3 0
Corynebacterium fascians	0
Erwinia carotovora	0
Rhizobium phaseoli	2 5
Rhizobium meliloti	1 8

The importance of this course of hexose phosphate utilization remains to be assessed For the species of *Xanthomonas* and *Pseudomonas* studied, it may be a major pathway, since little if any 6-phosphogluconate dehydrogenase activity has been demonstrated in sonates of these organisms as determined by measuring reduction of tri-(or di-)phosphopyridine nucleotide at 340 mμ in a Beckman *DU* spectrophotometer

Details of these experiments will be reported elsewhere. I am indebted to Dr W A Wood, of the University of Illinois, Urbana, Illinois, for suggestions concerning biochemical methods used in this work.

H Katznelson

Bacteriology Division,
Science Service,
Department of Agriculture,
Ottawa
Nov 8

---

[1] Entner, N , and Duodoroff, M , *J Biol Chem* , 196, 853 (1952)

[2] MacGee, J , and Duodoroff, M , *J Biol Chem* , 210, 617 (1954)

[3] Wood, W A , and Schwerdt, R F , *J Biol Chem* , 206, 625 (1954) Kovachevich, R , and Wood, W A , *Bact Proc Soc Amer Bact* , 109 (1954)

[4] Friedmann, T E , and Haugen, G E , *J Biol Chem* , 147, 415 (1943)

[5] Cavallini, D , Frontali, N , and Toschi, G , *Nature*, 163, 568 (1949)

[6] Umbreit, W W , Burris, R H , and Stauffer, J F , "Manom Tech and Tissue Metab " (Burgess Pub Co , Minneapolis, 1949)

[7] Lowry, O H , Rosebrough, N J , Farr, A L , and Randall, R J , *J Biol Chem* , 193, 265 (1951)

Inhibiting Effect of Trypan Blue on the Experimental Production of Liver Cancer

Recently, Gillman *et al* [1] and Simpson[2] reported that trypan blue injected subcutaneously into rats at weekly or bi-weekly intervals induced tumour (reticulum cell sarcoma) of the liver Trypan blue is a sulphonated dis-azo dye and somewhat resembles in chemical structure dimethylaminoazobenzene, which is a potent carcinogen for the liver of rats

The present communication deals with the results of the subcutaneous injection of trypan blue on the incidence and course of tumours induced by *p*-dimethylaminoazobenzene In these experiments 1–2 ml of a 1 per cent aqueous solution of trypan blue was injected subcutaneously at intervals of one to two weeks into rats of mixed breed weighing 80–100 gm which were also given 0 06 per cent dimethylaminoazobenzene diet The injections were continued until a total dose of 60–80 mgm of trypan blue had been given The control animals were given 0 06 per cent dimethylaminoazobenzene diet, but received no trypan blue The basal diet consisted of unpolished rice and contained 1 33 mgm of riboflavin per kgm , which encourages tumour induction and survival, and this was supplemented by green vegetables every two days The dimethylaminoazobenzene given to each rat amounted to about 600–700 mgm over a period of six to twelve months The experiments were terminated within one year and the incidence of liver cancer of the group injected with trypan blue was compared with the controls at periods of 6, 7–8 and 9–12 months after the commencement of the experiments

These results indicate that trypan blue delays the production of liver cancer by *p*-dimethylaminoazobenzene In the controls, the induced liver cancer reached a great size after six months and often metastases appeared in the abdominal lymph nodes and lungs In the groups of animals which received trypan blue for seven to eight months, the tumour incidence amounted to 33 and 100 per cent respectively , but these tumours were much smaller and more localized compared with the controls, in which the tumour incidence was practically 100 per cent During early trypan blue treatment, the rats showed less gain in weight and higher mortality due to respiratory infections than the controls, suggesting toxicity of the drug, while after five to six months they showed a considerable gain in weight whereas the controls showed a sustained loss

Histologically, a marked hepatic response could be observed in the liver of treated groups. During the first one to two months, the stellate cells in the liver sinusoids were large and plump, and filled with trypan blue particles, whereas in the later months of the experiment a characteristic proliferation of the histiocytic cells developed in the portal tracts with the stellate cells growing smaller and narrower. The hyperplasia and hypertrophy of the parenchyma cells of the liver, however, were more inhibited than in the controls

Recently, Miller *et al* [3] have shown that the levels of protein-bound carcinogenic azo-dyes in the liver are lower when the carcinogen is fed in diets containing high levels of riboflavin We measured the total protein-bound dimethylaminoazobenzene in the livers of the animals receiving trypan blue and in the control animals, using the method of Miller *et al.*[4] It was found that the difference in the two groups of animals was too small to explain the inhibiting effect of trypan blue *p*-Dimethylaminoazobenzene, however, was found in a slightly higher concentration in the trypan blue group, which suggests that trypan blue does not reduce the absorption of dimethylaminoazobenzene from the intestine or increase the rate of metabolism of it in the liver.

We wish to thank Profs Fukuzo Oshima and Kazuo Hotta for their encouragement and advice

S Iwase
K Fujita

Departments of Pathology and Biochemistry,
Nagoya University, Japan.
Oct. 10

---

[1] Gillman, J , Gillman, T , and Gilbert, C , *S Afr J Med Sci* , 14, 21 (1949)

[2] Simpson, C L , *Brit J Exp Path* , 33, 524 (1952)

[3] Miller, J A , "Advances in Cancer Research", 1, 389 (Academic Press, N Y , 1953)

[4] Miller, E C , and Miller, J A , *Cancer Research*, 7, 468 (1947)

Determination of the Life of Human Blood Platelets using Labelled Di*iso*propylfluorophosphonate

Hitherto no satisfactory method for the determination of the life of blood platelets has been described Recently a method has been reported for determining the life of erythrocytes using di*iso*propylfluorophosphonate labelled with phosphorus-32 [1] This method was based on the irreversible combination of this compound with esterases present on the red cell membrane Since thrombocytes have also been shown to contain esterase, the same method suggested itself as a way of measuring the life of these cells It seemed reasonable to assume that conditions similar to those described for red cells would be met This implies that the decay of radioactivity associated with platelets would be entirely due to the destruction of these cells and therefore an index of their normal breakdown This would only be true if no re-incorporation of labelled material in newly formed platelets were to take place This assumption seems justified, since it has been shown that the only demonstrable metabolite of di*iso*propylfluorophosphonate in the human body is di*iso*propylphosphate. This compound is not further metabolized but quickly excreted in the urine The labelled di*iso*propylfluorophosphonate used was synthesized by Mr Oosterbaan (M.B L , Rijswijk) by a method to be reported in the near future

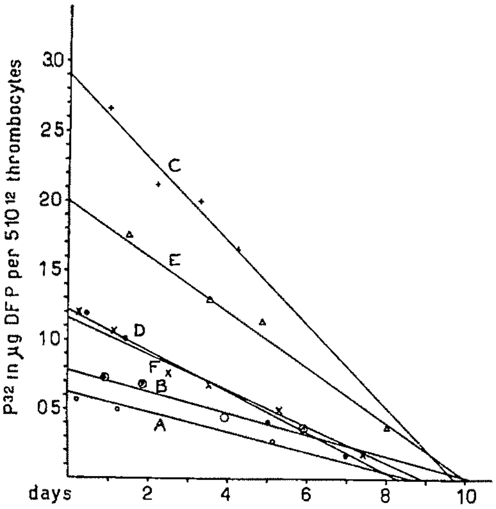


Fig 1

The labelled di*iso*propylfluorophosphonate was administered as before[1] From venous blood drawn into siliconized tubes using sodium sequesterene as anticoagulant, platelets were separated by a method of differential centrifugation Every care was taken to avoid any contamination of the final platelet suspension with other formed elements of the blood After determination of the cell concentration, the plasma was removed from a known volume of the final suspension The resultant platelet mass was washed three times with physiological saline and hydrolysed for 30 min at 100° C. in 3 ml. 30 per cent sodium hydroxide The volume was made up to 11 ml The radioactivity of this final solution was measured as described previously using a Geiger–Muller liquid counter By relating the measurements to controls obtained by alkaline hydrolysis of labelled di*iso*propylfluorophosphonate of known radioactivity, it was possible to determine the di*iso*propylfluorophosphonate content of the measured sample The same sample was used for the determination of the nitrogen content (Kjeldahl)

Measurements of platelet-bound radioactivity after injection of the labelled phosphonate was carried out at intervals in four normal persons (*A*, *B*, *C* and *D*), one patient with chronic myeloid leukæmia (*E*) and one patient with polycythæmia vera (*F*) The results are shown in Fig 1 The curves are drawn by the method of least squares The activity is expressed in micrograms di*iso*propylfluorophosphonate per 5 × 10^{12} platelets The results show that the decline of the activity follows a straight line, indicating the existence of a real life rather than random destruction The slope of the curve obtained suggests this life to be approximately nine days Similar curves are obtained when the activity is expressed per gram platelet nitrogen This figure might possibly be in some cases somewhat exaggerated due to contamination with radioactivity from other cells. This contamination reveals itself sometimes in a slight residual activity after the ninth day However, such activity is so small that it cannot account for an exaggeration of more than one day The life of the platelet should therefore be estimated at eight to nine days Large variation in radioactivity and in amounts of di*iso*propylfluorophosphonate used occurred in these experiments These facts suggest that toxic action or radioactivity does not seriously interfere with the life of the platelets under our conditions A more detailed account of the method will be published elsewhere

We are indebted to Miss C H Posthumus for technical assistance

C. H. W. LEEKSMA
Department of Metabolic Diseases,
University of Leyden
J A COHEN
Medical Biological Laboratory of the
National Defence Research Council T N O ,
Rijswijk, Holland
Nov 26

---

[1] Cohen, J A , and Warringa, Mia G P J , *J Clin Invest*, 33, 459 (1954)

Plant Hyperplasia induced with a Cell-free Insect Extract

ALTHOUGH the mechanism of plant-gall formation by insects has long provided a field for speculation, there are few records of attempts to induce such growths experimentally The range of successful essays is practically limited to trials with Cecidomyid larval secretions and egg extracts in lanolin, injections of salivary gland extracts from a Coccid and *Adelges abietis*[1], and Martin's reproduction of pseudo-galls on sugar-cane with whole-insect extracts of a Jassid and other insects[2]

In the present experiments, Martin's technique was used in principle Mature larvæ of two generations of *Dasyneura urticae* Perris (Diptera Cecidomyiidae), which causes unilocular, slightly hairy galls on leaves, stems and flowers of *Urtica dioica*, were taken from sectioned galls and macerated in distilled water to give an extract of 50 larvæ/ml In a second series, only larval heads were used The macerate was filtered under slight vacuum, and the cell-free extract injected at once with an ultra-fine hypodermic needle into leaf bases of *U dioica*, using the three youngest leaves on each stem Attention has been directed[3] to the technical difficulty of directing the stimulus to the cambium , but it has also been held[4] that pre-existing meristems are not necessarily implicated in gall initiation, all cells having a reaction potential to stimuli

Out of a hundred and fifty injections with whole larva extract, and fifty with head-only extract, growth at the site of injection was noted within seven days in twelve and nine instances respectively, suggesting that the head provided the stimulant No growth occurred in fifty water-injected controls The growths did not resemble normal galls of *D urticae*, probably because of the short-lived impact of the stimulant The thickness of the parenchyma was increased by from two to five cells, with the epidermis consequently slightly raised Kataplastic hyperplasia was thus demonstrated, but no nuclear irregularities were observed (Longitudinal cell division has been described in *D. urticae* galls by Meyer[5]) No further growth occurred, nor was there subsequent reabsorption

Although the results do not resolve the problem as to whether gall formation is initiated by an insect secretion or by a plant response, they do show that cell division is promoted by a chemical present in fully grown larvæ of a host-specific Cecidomyid The zoological contribution to gall formation is therefore not confined to stimulants introduced at the time of oviposition or secreted only by newly hatched larvæ

A detailed account of this work will appear elsewhere, when studies with a prolonged stimulus have been completed

DONALD LEATHERDALE

Eastfield Lodge,
Whitchurch,
Pangbourne, Berks
Nov 29.

---

[1] Boysen Jensen, P , *Physiol Plant* , 1, 95 (1948) Clausen, R -L , *Mitt Schweiz ent Ges* , 23, 205 (1950) Parr, T , Bull Yale Univ Sch For , 46, 27 (1940) Plumb, G H , Bull Conn Agric Exp Sta , 566, 58 (1953)

[2] Martin, J P , *Hawaii Plant Rec* , 42, 129 (1938), *Science*, 96, 39 (1942)

[3] Needham, J , "Biochemistry and Morphogenesis", 108 (Cambridge, 1942)

[4] Butler, E J , *Ann App Biol* , 17, 175 (1930)

[5] Meyer, J , *Rev Cyt* , *Paris*, 7, 218 (1944)

Colloid Osmotic Pressures of Dextran, Serum and Dextran–Serum Mixtures

THE polysaccharide dextran is widely used for expanding the plasma volume or augmenting the colloid osmotic pressure of patients in whom the total circulating protein is reduced No direct measurements have as yet been reported on mixtures of serum with dextran, although measurements made by Wales *et al* [1] on dextran–albumin mixtures are in conformity with the results described here.

Colloid osmotic pressure measurements have been made with a new instrument[2] which uses a mechano-electronic transducer to detect movements of very small volumes of fluid across a semi-permeable membrane In order to obtain reproducible results, it was found necessary to prepare nitrocellulose membranes which were substantially impermeable even to the smaller dextran molecules in the batch investigated With these membranes the osmotic pressure did not alter significantly between 30 min and 16 hr. When using membranes which were permeable to some dextran molecules but still impermeable to the serum proteins, it was found that the osmotic pressures, even on extrapolation back to zero time, might be considerably lower than those measured with the impermeable membranes This observation agrees with that of Grim[3], who used glucose and leaky nitrocellulose membranes

Fig. 1 shows the relationship between colloid osmotic pressure and colloid concentration for a transfusion batch of dextran ('Dextraven' batch 3525), normal human serum, and a mixture containing dextran and serum proteins in the ratio 43 to 57. The plot for dextran is sharply curved, so that only at low dextran concentrations can the colloid osmotic pressure be regarded as a simple function of the number average molecular weight (M_N) The plot for serum is less curved, and at low concentrations has a gradient similar to that of the dextran, that is, M_N for the two colloids is similar

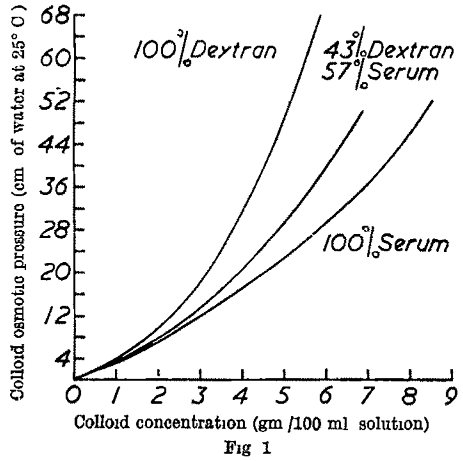


Fig 1

Table 1 CALCULATED AND OBSERVED COLLOID CONCENTRATIONS OF DEXTRAN–SERUM MIXTURES FOR VARIOUS COLLOID OSMOTIC PRESSURES

Colloid osmotic pressure (cm water at 25° C)	Dextran percentage of total colloid	Colloid concentration (gm /100 ml solution) Observed	Calculated
50 0	43	6 85	6 90
25 5	43	4 55	4 55
9 6	43	2 30	2 30
17 5	60	3 26	3 35
28 7	69 5	4 24	4 45
38 9	53	5 53	5 70
16 6	27 5	3 57	3 60
22 4	20	4 87	4 65
35 8	33 5	5 85	5 95

'Calculated' colloid concentrations of mixtures are derived from observed concentration curves of pure serum and pure dextran giving corresponding colloid osmotic pressures

Table 2 COLLOID OSMOTIC PRESSURE INCREMENT DUE TO PRESENCE OF DEXTRAN IN DEXTRAN–SERUM MIXTURES

Serum protein Concentration (gm /100 ml solution)	Colloid osmotic pressure (cm water at 25° C)	Increment in colloid osmotic pressure due to dextran concentration in mixture (gm /100 ml solution) 1 per cent	2 per cent	3 per cent	4 per cent	5 per cent
0	0	4	9 5	17 5	30	48
1	4	4 5	10 5	21	35	—
2	8	5 5	13 5	25 5	39 5	—
3	12	6 5	16 5	30 5	—	—
4	16 5	8	19 5	36 5	—	—
5	22	10	24	—	—	—
6	28 5	12	—	—	—	—
7	36	15	—	—	—	—
7 5	40 5	—	—	—	—	—

The curve for the dextran–serum mixture lies between those for dextran and serum , for any given colloid concentration the curve for the mixture (nearly half of which is dextran) indicates a colloid osmotic pressure much closer to the serum than the dextran. But inspecting the position of the curves for any given colloid osmotic pressure, the colloid concentration of the mixture is seen to have a value approximately midway between the corresponding dextran and serum values This finding encourages the view that calculations might be based, for any value of colloid osmotic pressure (p), on the expression

$$[\text{dextran}_p]\,x + [\text{serum}_p]\,(1-x) = [\text{mixture total colloid}_p]$$

where $[\text{dextran}_p]$, $[\text{serum}_p]$, etc , are the concentrations of dextran, serum, etc , giving an osmotic pressure of p, and x is the proportion of dextran in the final mixture. In Table 1 the results of a number of such calculations are shown which are in reasonable agreement with the corresponding experimental determinations

This expression has been used for calculating Table 2, which shows that doubling the dextran concentration at any serum protein-level more than doubles the osmotic pressure increment due to the presence of dextran, and also that the lower the serum protein concentration the less the increment of osmotic pressure from any given dextran concentration.

The number average molecular weight of the dextran cannot therefore be used to calculate the expected osmotic pressure increment, and, in fact, a 2 per cent dextran of M_N about 300,000 in the presence of 3 per cent serum proteins gave an osmotic pressure increment of 14 cm of water compared with 16 5 cm. of water for the transfusion batch of M_N about 80,000

These results indicate that the initial colloid osmotic effect of a given dose of dextran is likely to depend not only upon its number average molecular weight, but also upon its osmotic pressure/concentration curve and the concentration of the plasma proteins In addition, the permeability of the capillary walls may be such that the maximum possible osmotic pressure is not exerted across them even before much dextran has leaked into the extracellular fluid

Loss of dextran into the urine, which always occurs with the currently available preparations due to their content of low molecular-weight material, also complicates any attempt to make exact predictions of *in vivo* effects from *in vitro* measurements

I thank Prof J R Squire for his interest. Samples of dextran were generously supplied by Messrs. Bengers, Ltd, and Messrs Glaxo Laboratories, Ltd. This work was done during the tenure of a grant from the Medical Research Council

D S. Rowe

Department of Experimental Pathology,
University of Birmingham,
Birmingham 15.

Dec 1.

---

[1] Wales, M, Rothman, S, Stasny, R J, and Weissberg, S G, National Bureau of Standards Report, No 3123

[2] Rowe, D S, *J Physiol*, 123, 18P (1954)

[3] Grim, E, *Proc Soc Exp Biol*, *N Y*, 83, 195 (1953)

Separation of Flavins by Ion-Exchange Resins

Flavin compounds have been separated from each other by using a chromatopile[1], by using various kinds of adsorption and partition chromatography[2], and by chromatography on powdered cellulose[3]. A simpler and easier method using an ion-exchange resin is described in this communication

Using an anion-exchange resin, Cohn *et al* have reported the separation of adenosine and adenosine mono-, di- and tri-phosphates[4], and that of choline and its ester[5]

For the separation of flavin compounds by ion exchange, several ion exchangers were examined, and the anion-exchange resin, 'Dowex-1', was found to be the most suitable 0 5 gm of the resin of 100 ∼ 150 mesh was placed in a brown-coloured glass tube of 8-mm diameter, making a bed of depth 20 mm After conversion of the resin to salt-type, the aqueous solution containing a mixture of flavin compounds was passed through at a flow-rate up to 2 ml /min, and the flavins were adsorbed. Free riboflavin and flavin mononucleotide used in these experiments were chemically synthesized crystals, and flavin adenine dinucleotide was prepared from hog liver by the method of Warburg and Christian[6] and purified in a chromatopile[1].

The exchanger column was fractionally eluted with aqueous salt solutions at a flow-rate of 2 ml /min by changing the concentration of the salt in the solvent or changing both the concentration and *p*H of the solvent.

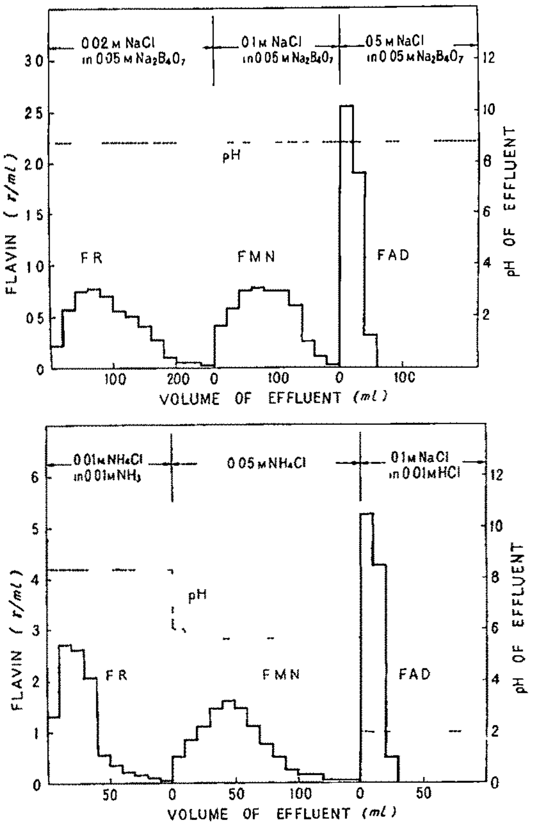


Fig 1 Anion-exchange separation of flavins bed, 'Dowex-1 × 4', 100 ∼ 150 mesh, 50 mm ² × 20 mm , flow-rate, 2 ml /min

The two fractional elution procedures were as follows (1) Change in the concentration of the salt. The resin was washed with 0 05 *M* borax (*p*H 8 8), and a solution containing 100γ each of riboflavin, flavin mononucleotide and flavin adenine dinucleotide in 0 05 *M* borax (*p*H 8 8) was adsorbed on the resin. Riboflavin was obtained on elution of the resin with 0 05 *M* borax containing 0 02 *M* sodium chloride, flavin mononucleotide with borax solution containing 0 1 *M* sodium chloride and flavin adenine dinucleotide with borax solution containing 0 5 *M* sodium chloride

(2) Change in the concentration of salt and *p*H of the solvent. After the resin has been washed with 0 01 *M* ammonium chloride in 0 01 *M* ammonia aqueous solution (*p*H 8 4), and the solution of 100γ of each of the flavins dissolved in the above-mentioned solution was passed through, riboflavin was not adsorbed and immediately obtained as the initial effluent Then, from the flavin mononucleotide and flavin adenine dinucleotide adsorbed, the former was obtained on elution of the resin with 0 05 *M* ammonium chloride at *p*H 5 6, and the latter with 0 1 *M* sodium chloride in 0 01 *M* hydrochloric acid at *p*H 2 0

In these experiments, flavin compounds were identified by paper chromatography[7] and the quantities present determined by the lumiflavin fluorescence method[8] The results are shown graphically in Fig 1 These graphs show that the flavin compounds were separated completely from each other, and that the methods described can be applied for the fractional determination of the nucleotides of riboflavin and the purification of flavin adenine dinucleotide

K. YAGI
J OKUDA
Y. MATSUOKA

Department of Biochemistry,
School of Medicine,
Nagoya University.
Oct. 17

[1] Yagi, K , and Ishiguro, I , *Vitamins (Japan)*, **3**, 29 (1950)
[2] Dimant, E , Sanadi, D R , and Huennekens, F M , *J Amer Chem Soc*, **74**, 5440 (1952)
[3] Whitby, L G , *Biochem J* , **54**, 437 (1953)
[4] Cohn, W E , and Carter, C E , *J Amer Chem Soc* , **72**, 4273 (1950)
[5] Sheppard, C W , Cohn, W E , and Mathias, P J , *Arch Biochem Biophys* , **47**, 475 (1953)
[6] Warburg, O , and Christian, W , *Biochem Z* , **298**, 150 (1938)
[7] Crammer, J L , *Nature*, **161**, 349 (1948)
[8] Yagi, K , *Vitamins (Japan)*, **6**, 528 (1953)

Circular Chromatography of Terpenes on Adsorbent Coated Glass

THE 'chromatostrip' method of Kirchner, Miller and Keller[1] for the separation and identification of terpenes and related compounds is a useful technique in a field where chromatography has been little applied The method consists essentially of coating glass strips with an adsorbent (silicic acid), oven-drying and cooling *in vacuo* over potassium hydroxide The oil is spotted near one end of the strip, which is developed by capillary ascent in a similar manner to paper strips. Spots or zones are located by spraying with reagents, one of the most useful being concentrated sulphuric acid, with which most components of essential oils give characteristic colours. Kirchner *et al* have indicated the usefulness of the method for two-dimensional chromatography, and Reitsema[2] has used glass plates on which a number of oils were directly compared.

In this laboratory the method has been adapted to the circular technique first described by Rutter[3] and has resulted in better resolution of zones, with the added advantage that as many as six oils may be conveniently compared on one plate 'Magnesol' (hydrated magnesium silicate) has given better results than silicic acid

Circular glass plates (5½ in. diameter) are coated with the adsorbent in a similar manner to that described by Kirchner *et al* [1], except that 'Magnesol' is used instead of silicic acid The plates are dried for ½ hr. at 105° C and cooled for ½ hr under vacuum over potassium hydroxide The plate is then spotted at its centre with the oil to be examined, and placed adsorbent side down over a 5-in diameter Petri dish containing a few millilitres of solvent. In the centre of the Petri dish a 1/16-in diameter cotton wick, held upright by passing it through a hole in a metal support, feeds the solvent on to the plate at the oil spot A wooden jig is used for centring the wick and the plate accurately The movement of the solvent can be seen through the glass and the position of the solvent front is marked with a glass pencil on the upper side of the plate When measuring R_F values, the adsorbent is scraped off the glass above the pencil marks Rate of development is controlled by the diameter of the wick and its degree of contact with the plate About thirty minutes development gives good resolution for a radius of 2¼ in from the point of contact.

The method has proved most useful in comparing the essential oils of hybrid *Eucalyptus* species with those of the parent trees

L H. BRYANT

Division of Wood Technology,
Forestry Commission of New South Wales,
96 Harrington Street,
Sydney.
Nov 19

[1] Kirchner, J G , Miller, J M , and Keller, G J , *Anal Chem* , **23**, 420 (1951)
[2] Reitsema, R H , *Anal Chem* , **26**, 960 (1954)
[3] Rutter, L , *Nature*, **161**, 435 (1948) , *Analyst*, **75**, 37 (1950)

Inverted Rhythmic Precipitation

MANY examples of rhythmic precipitation occur in geological and biological formations, where the separation of the rings of precipitate (of copper carbonate, calcium phosphate, etc) decreases with the direction of diffusion of flocculating solution, and these have not generally been considered true cases of the Liesegang phenomenon[1]. The laboratory techniques[2,3] that are generally used for the study of rhythmic precipitation *in vitro* have always led to the typical spacing relation, for X_{n+1}, the position of the $(n + 1)$th ring,

$$X_{n+1} = (d_n - d_0) = ak^n \qquad (1)$$

where d_0, d_n are the distances of the first and $(n + 1)$th ring from the origin of diffusion[4]. With such techniques, X_n always increases geometrically with n, as the concentration of coagulating ion gradually decreases along the diffusion path[3,5] When the diffusing ion, on the other hand, acts as a peptizer, no precipitation is observed

I have developed a new technique for obtaining inverse rhythmic precipitation, similar to that observed in many natural formations The ammonia-peptized sol of an insoluble metal salt dispersed in a fluid gelatine suspension is coagulated by diffusing a mixed solution of acetic acid, together with a third peptizing ion of slower rate of diffusion, into the set gel (cf ref 6)

The concentration of peptizer is greatest at planes nearest to the origin of diffusion, and the separation of the rings now decreases with n.

The following results have been obtained with 0 005 M silver chromate sols peptized by 0 050 N ammonia, in 5 per cent dialysed gelatine gels. 1 c c. of the mixed solution was diffused into 15 c c of gel contained in test-tubes, and the precipitation observed for six to eight days. Measurements of d were made with a cathetometer[3].

Peptizing cation. (i) Precipitation with acetic acid plus copper nitrate solution Over the range of concentrations, 2 N – 0 5 N acetic acid, 0 5 N – 0 1 N cupric ions, silver chromate is precipitated as a normal series of rings[6], followed at the plane A (Fig 1), about 2 cm from the origin of diffusion (O), by a series of rings of large silver chromate crystals These rings become closer together along the diffusion path, and at a plane B, at distance d_∞ from O, a band of flocculated precipitate is formed The distance (X_n) of the nth ring from A is now given by the relation,

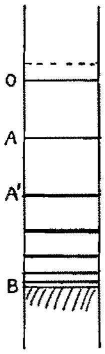


Fig 1

$$X_n = (d_\infty - d_n) = ak^{-n} \qquad (2)$$

where a and k are constants. d_n is the distance of the nth ring from O (as in equation (1)) a has now a geometrical significance, and is equal to AB, the separation of the first two rings. Values of d_∞, a and the spacing coefficient $(k - 1)$ are given in Table 1

Table 1 INVERSE PRECIPITATION OF $M/200$ SILVER CHROMATE

	d_∞	a	$(k-1)$
2 *N* Acetic acid			
plus 0 5 *N* cupric ions	4 2 cm	2 0 cm	0 234
0 2 *N* ,, ,,	2 7	0 8	0 100
0 1 *N* ,, ,,	1 5	<0 2	<0 020
N Acetic acid			
plus 0 2 *N* cupric ions	fully peptized		>1 000
0 1 *N* ,, ,,	4 0 cm	1 7 cm	0 450

(ii) Precipitation with acetic acid plus lead nitrate solution The usual rings of silver chromate first formed by the rapidly diffusing acetic acid are in turn gradually changed into rings of lead chromate which form by displacement (unpublished work) These latter are then peptized by excess lead ions After 16 hr, a system of inversely stratified lead chromate precipitate appears on a background of yellow sol, over the range *N* – 0 1 *N* acetic acid, 0 5 *N* – 0 1 *N* lead ions

The rhythmicity is not sufficiently clear for accurate observations to be made without photoelectric instruments

Peptizing anion (iii) Precipitation with acetic acid plus potassium iodide solution As in (ii), the silver chromate first formed is displaced by rings of silver iodide, which are in turn peptized to form an inversely precipitated system of pale yellow silver iodide rings on a background of silver iodide sol. For this system, also,

$$X_n = ak^{-n}$$

Values of d_∞, a and $(k - 1)$ are given in Table 2.

Table 2 INVERSE PRECIPITATION OF $M/100$ SILVER IODIDE

	d_∞	a	$(k-1)$
5 *N* Acetic acid			
plus 0 5 *N* iodide ions	6 0 cm	3 0 cm	0 670
0 2 *N* ,, ,,	4 6	2 0	0 462
0 15 *N* ,, ,,	3 4	1 0	0 380
2 *N* Acetic acid			
plus 0 5 *N* iodide ions	5 5 cm	2 4 cm	1 000
0 2 *N* ,, ,,	3 4	1 5	0 591
0 15 *N* ,, ,,	1 4	0 6	0 305
N Acetic acid			
plus 0 5 *N* iodide ions	4 7 cm	1 7 cm	1 424
0 2 *N* ,, ,,	2 9	1 0	0 825
0 15 *N* ,, ,,	0 9	0 4	0 440

As in Table 1, with increase in the initial concentration (C_0) of peptizer, $(k - 1)$, a and d_∞ all increase with fall in initial concentration of acetic acid, the total extent of diffusion of the coagulant, and hence that of the silver chromate precipitation, decreases d_∞ and a thus decrease, but since more free ammonia will now be present at any plane, the spacing coefficients still increase[6]

For any initial acetic acid concentration, $(k - 1)$ varies with the value of peptizer concentration, according to the relation,

$$(k - 1) = \overline{A} - \overline{B}/C_0 \qquad (3)$$

(see Fig 2)

$\overline{A}$ is the spacing at infinite initial peptizer concentration, and increases inversely with concentration of acetic acid (C_{HAc}) The variation of $(k - 1)$ with concentration of acetic acid at constant initial concentration of peptizer, indeed, follows the general relation, obtained for normal rhythmic precipitation[3],

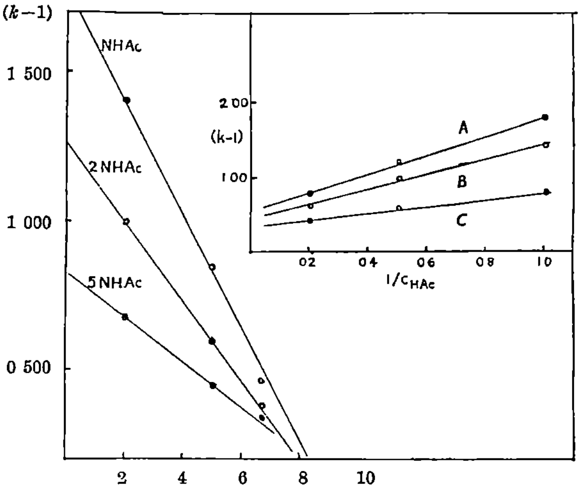


Fig 2 Curve A, $\infty NI'$, curve B, 0 5 NI', curve C, 0 2 NI'

$$(k - 1) = A + B/C_{\mathrm{HAc}} \qquad (4)$$

(see Fig 2).

The above work was carried out at the Department of Physical Chemistry, King's College, London, during a period of postgraduate research I wish to thank Sir Eric Rideal for his interest and helpful discussion.

A PACKTER

F. W Berk and Co.,
Clay Development Laboratory,
London Colney, Herts Nov 15

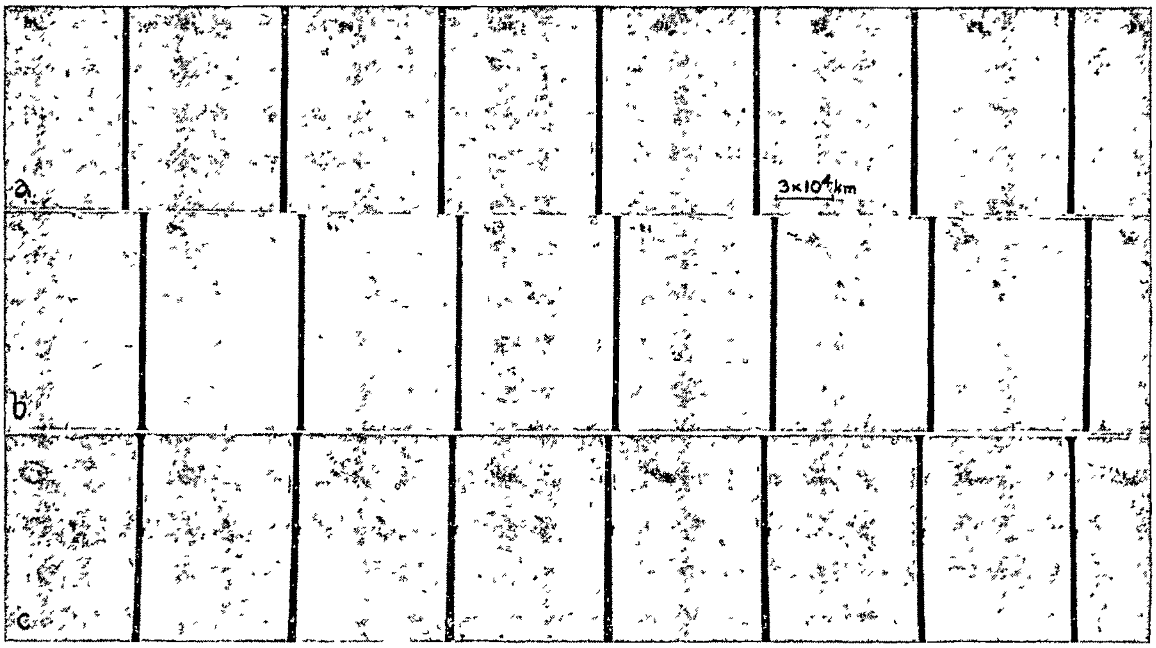
[1] Alexander, A E, and Johnson, P, "Colloid Science", 603 (Clarendon Press, Oxford, 1949)
[2] Liesegang, R, *Z phys Chem*, 23, 365 (1897)
[3] Packter, A, and Matalon, R, *J Coll Sci* (in the press)
[4] Jablczynski, K, *Bull Soc Chim Fr*, (4), 33, 592 (1923)
[5] Wagner, C, *J Coll Sci*, 5 (1), 85 (1950)
[6] Packter, A, thesis, University of London (1953)

Intensity Variation in Sunspots

IN view of the observations of Dr. R. Ananthakrishnan[1] and his remark concerning the reality of the brightening of that part of the penumbra of a sunspot which is adjacent to the umbra, the attached print is of interest

These photographs were taken on August 11, 1954, and are part of a ciné record of a sunspot group made between 14 15 and 14 30 U.T The light-sensitive material was Eastman 548-*GH* emulsion coated on 16-mm base Exposure was made with a Bolex camera, without lens, situated at the focus of a 6-in aperture, 480 in focal length horizontal refractor No filter was used, so that the spectral range recorded is from the ultra-violet cut-off of the optical equipment (about 3000 A) to the limit of the sensitization treatment of the emulsion (about 5700 A). The frame-rate of the motion-picture camera was 8 per sec, so that each strip has a total duration of one second, with the time increasing from left to right in each case The shutter speed for each frame was 1/70 sec

Strip (*a*) was taken very early in the series and shows very little penumbra and very little brightening immediately surrounding the umbra Strip (*b*) was exposed about two minutes after (*a*). This strip shows



an abnormally bright region surrounding the umbra which is soon obscured or obliterated by the rapidly forming penumbra Strip (*c*) was exposed about one minute after (*b*) Here the brightening next to the umbra is very much enhanced and appears to be almost the size of the penumbra, which is still well developed The brightened area appears to be in violent motion. The speed shown by the 'flare' in frame 5 of (*c*) is of the order of 50,000 km per sec, which would seem to prove that this is due to excitation rather than motion of material

I have been unable to obtain solar noise records for 2,700–3,000 Mc/s. for the time during which the photographs were made Some H_α flare activity was noted in this region during this time, but, to my knowledge, none occurred while the pictures were being taken

This work was supported, in part, by the U S. Army Signal Corps, under Contract No. *DA*36-039-*sc*-64524

WILLIAM A. MILLER

RCA Solar Observatory,
Rocky Point,
New York Nov 1

---

[1] *Nature*, 168, 291 (1951)

Germanium in Power Station Boiler Plant

CRAWLEY[1] has reported the results of a search for germanium in the waste products of the major coal-burning industries of Britain We have determined the quantity of germanium in more than sixty samples of dust and deposits taken from various types of steam-raising plant within the British Electricity Authority, the results have not been encouraging

In boilers fired with pulverized fuel, nearly all the ash from the fuel is carried forward with the flue gases, and it is therefore unlikely that appreciable enrichment of germanium will occur in the fly-ash. Analysis of several samples of fly-ash confirmed that the germanium content was very low, and even ash which had remained in the plant for some time, for example at the base of the chimney, was found to contain only 0 01 per cent When the fuel is burned in a stoker-fired furnace, however, only a few per cent of the total ash in the fuel is carried forward and some enrichment due to condensation or adsorption on the fly-ash might be expected. The maximum concentration found in such ashes was only 0 015 per cent

Selective condensation of inorganic constituents of the coal causes deposits to be formed in varying quantities throughout the boiler It has been found that many of these deposits contain more germanium than the coals from which they were derived, but in only two, both from the superheater, was the germanium content greater than 0 1 per cent, which is the minimum concentration likely to repay recovery The maximum concentration found was 0 16 per cent Amounts between 0 05 and 0 1 per cent were found in ten out of forty samples of deposit taken from various parts of the system, including the induced-draught fans. The remainder of the deposits contained 0 003–0 05 per cent It appears from these figures that deposits from steam-raising plant only occasionally contain useful amounts of germanium Even then, the quantities of these deposits available are usually small, at most, about a ton could be recovered with some difficulty from one boiler in a year

If the conditions of combustion and the constituents in the coal which affect the release of germanium could be determined, it might be possible to forecast which boilers were likely to have deposits rich in germanium. Experiments are therefore being made to see whether pyrites and the chlorides of sodium and potassium affect the release of germanium during the combustion of coal.

J S FORREST
A C SMITH
J M. WARD

Research Laboratories,
British Electricity Authority,
Randall's Farm Lane,
Leatherhead
Feb 25

---

[1] Crawley, R H A, *Nature*, 175, 291 (1955)

Longitudinal and Screw Vibrations of Beams

RAYLEIGH'S method has been applied recently by us to examine the modes of vibration of beams and the relationships between the modes One result of some interest is the interference with the fundamental modes of two types of oscillation which we have called 'screw vibrations' These vibrations, although simple in nature, are generally ignored, perhaps because they have a minimum frequency of excitation.

Travelling waves in a circular cylinder can be distinguished, when the wave-length is considerably greater than the diameter, by the nodal surfaces, or the nodes in a normal cross-section. The fundamental modes of oscillation without nodes are the longitudinal and torsional modes In addition, there are harmonics with nodal cylinders at a distance from the axis, and there are vibrations with nodal planes which cut the axis (there are other harmonics with both types of node) The first and second vibrations with nodal planes are the flexural and screw vibrations respectively.

If the z-axis is along the axis of the beam, and the axes OX, OY are principal axes of inertia of the normal cross-section with radii of gyration b, a respectively, then the displacements for the two screw vibrations from our approximate theory are

$$\text{(i)}\ u = \mathrm{A}\,x\sin(kz-\omega t),\ v = -\mathrm{A}\,y\sin(kz-\omega t),\ w = 0$$

$$\text{(ii)}\ u = \mathrm{B}a^2y\sin(kz-\omega t),\ v = \mathrm{B}b^2x\sin(kz-\omega t),\ w = 0$$

for long wave-lengths The name 'screw vibrations' was given since this seemed to describe the motion fairly well It is also clear from (i) that the motion can be alternatively described as a squeezing motion, where the rod is squeezed first along the x-axis and then along the y-axis, and that (ii) can be described in the same way if the axes are rotated through 45°. For a circular or square beam these two vibrations are identical, but they are not for a rectangular or elliptical beam

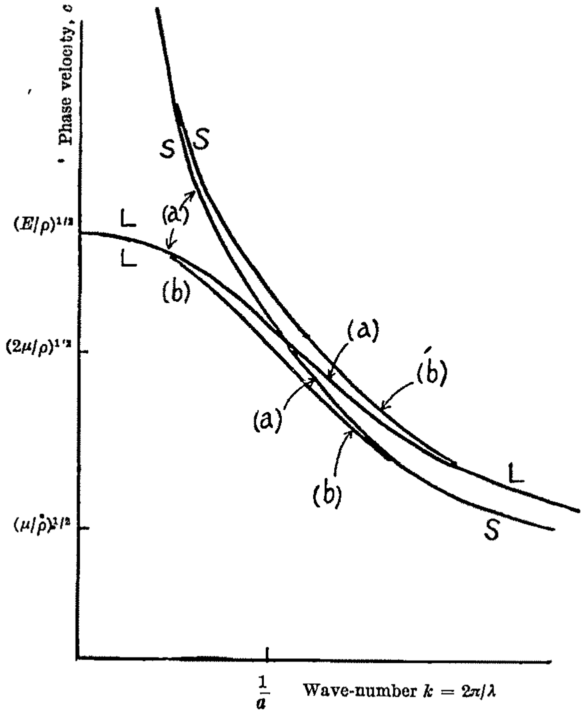


Fig 1 Interference of longitudinal and screw vibrations L = longitudinal type, S = screw type (*a*) Circular or square beam, (*b*) elliptical or rectangular beam

The importance of these vibrations lies in the fact that they interfere with the longitudinal and torsional vibrations. In our approximate theory, as shown in Fig 1, the dispersion curve of a circular cylinder for the longitudinal vibration cuts that for the screw vibration (i), when the phase velocity is $\sqrt{2}$ times the shear-wave velocity Being of the same symmetry, the two interfere for a rectangular or elliptical cylinder. The result is that the fundamental mode, believed to be longitudinal, changes its character from longitudinal to screw as the wave-length passes through a value equal to the diameter of the beam, and the excited mode changes from screw to longitudinal These conclusions have now been verified by exact calculations They seem to be the first true example in this field of coupling between oscillations, the coupling constant being a shape parameter

Evidence that this transition actually takes place is at the moment limited, but it should be easy to verify It certainly agrees well with the observations of Morse[1] who, trying to excite longitudinal vibrations, found it much easier to obtain the higher branch at high frequencies. Also Mr. A. B Lewis, in the Physics Department of this College, has been observing longitudinal vibrations using lycopodium powder and has found in one or two cases that the powder, instead of being distributed in rings about the axis of his cylinder, has lain in spirals at some places

The second screw vibration (ii) interferes in the same way with the torsional oscillation The approximate theory gives the interference without an actual intersection of the curves, but this intersection has since been found by Mr A Green, of this Department, in the course of some exact calculations of the torsional oscillations of non-circular beams

In view of the simple form of the oscillation, it should be possible to devise an elementary or engineering theory of the screw oscillation; but this has not yet been done.

G. J. KYNCH

Department of Applied Mathematics,
University College of Wales,
Aberystwyth
Dec 2

---

[1] Morse, R W, *J Acous Soc Amer* 20 833 (1948)

An Interferometer for 'Straightness' Measurement

IT is sometimes required in engineering practice to measure the flatness of a surface, such as that of a surface plate, with considerable accuracy. A similar problem arises in checking the straightness of a mechanical motion, such as that of a lathe cutting-tool To perform such a measurement with sufficient accuracy is not easy if the dimensions are too large to allow of an optical flat being used as a reference surface

An interferometer has been constructed which enables such measurements to be made The optical system, shown in Fig 1, is based on two identical concave mirrors, separated by their common radius of curvature, so that the centre of curvature of each lies in the face of the other. The reference 'straight' is then defined by the line joining the two centres

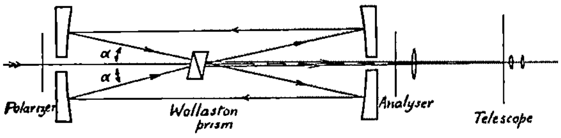


Fig 1 Optical system of 'straightness interferometer'

of curvature Light enters through a small hole in one mirror, and proceeds along the axis until it strikes a beam-splitting device, which may conveniently be a Wollaston prism It is thereby divided into two beams which, after successive reflexion at the two mirrors, converge on to the prism once more. It is easy to show that this is the case for any axial position of the prism Each beam is then refracted once more, and the two beams pass through a hole in the second mirror in a direction parallel with the axis and with each other, but separated by a small amount

If the original beam be polarized at 45° to the principal directions of the prism, and an analyser placed in the beam upon its emergence from the system, interference fringes will be observed in the focal plane of a telescope These fringes will move if the Wollaston prism be displaced at right angles to the axis in the plane of the diagram, but will not move for a displacement in any other direction. If the angle made by each beam with the axis be α, and the wave-length be λ, the displacement of the prism for a motion of one fringe of the fringe system will be $\lambda/(4 \sin\alpha)$

In use, the prism may be mounted on a moving member of which it is desired to check the straightness of path, or suitably attached to a stylus which moves over the surface to be examined The motion of the fringes then indicates the deviation of its path from the line of centres of the mirrors

It is convenient to introduce a compensator to return the central white fringe to a fiducial mark in the eyepiece at each measuring point The deviations are then read from a scale on the compensator

An experimental model, using mirrors 3 in in diameter and 20 in apart, with a prism giving an angle α of about 0 06, gives a sensitivity of about 0 00008 in per fringe, allowing a reading accuracy, if the compensator be set to one-tenth of a fringe, of about 8 micro-inches It is found that successive runs are repeatable to about this figure.

The spherical aberration introduced by the two mirrors is not negligible but, because of the symmetry of the system, it does not give rise to any error.

J Dyson

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston Court,
Aldermaston, Berkshire

Nov 24.

Effect of Time of Embryo Formation on Quantitative Characters in *Drosophila*

In preliminary studies on the causes of variability in pure lines of *Drosophila melanogaster*, using the quantitative character of sternopleural chæta number, it was noted that a relationship existed between chæta number and time of hatching This could have been due entirely to changes taking place in the culture media[1,2], but experiments have now shown that some part of this variability is already determined before the eggs are laid and is, furthermore, inherited

Pairs of flies taken from the Samarkand line, which has been sib-mated for more than three hundred generations, were transferred at 12-hr intervals through a relay of six tubes to remove effects of staling media The curve obtained on summing the results of several experiments repeated at different times ('Samarkand relay', Fig 1) differs from the type of curve produced when no relay is employed, but may be related to the changes found by Robertson and Sang[2] to occur in the physiological activity of the female with advancing age. On taking several pairs of flies at 12-hr intervals from an ordinary culture tube, and maintaining separate lines for three generations by mating flies from the respective hatching periods, the combined family means curve ('Samarkand time selection', Fig 1) was found to be closely correlated with that of the 'Samarkand relay' From this it appears that the variability determined prior to egg-laying is inherited, but, as one might expect, the response to environmental effects in the tube is not Hence selection within an inbred line is possible.

The curve may be altered by taking parents, or grandparents in the first instance, from different hatching periods If, therefore, parents are taken at random in replicating experiments of this nature, seemingly inconsistent results may be obtained, thereby leading to a conclusion of random variation. Oregon, a more prolific and long-lived inbred line, gives the same type of curve, but it is interesting to note that the curve is more pronounced and drawn out over the longer life-span On this account alone Oregon must be considered a more variable line.

Under certain summations, chæta number shows a negative correlation with the number of flies hatching, but the relation is not complete and in some cases it may be positive Should this be substantiated by further experiments, then it would appear that factors (presumably cytoplasmic) responsible can segregate independently of each other

Age of parents has been shown to influence the character of the offspring in a number of organisms,

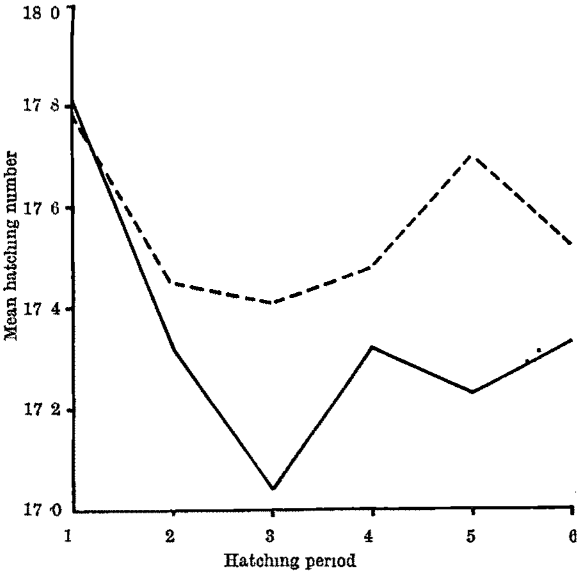


Fig 1 Samarkand relay, ———, Samarkand time selection, - - - -

and recently Mather[3], in reviewing a symposium[4] on the subject, directs attention to the significance of those findings. Some further points of immediate interest follow. (i) A large part of the variability in at least two inbred lines of *Drosophila*, generally ascribed to residual heterozygosity or uncontrollable environmental variation, is governed by the time of embryo formation. In common with the lower organisms, *Lemna*[5], *Philodrina*[6] and *Aspergillus*[7], there is here an extra-chromosomal mechanism of inheritance. (ii) Greater emphasis must be placed on good sampling technique in taking flies for examination or mating. Taking flies from a set period is not advisable, since the time-effect not only varies with lines but also shows some interaction with generations. (iii) The use of an inbred control for removing some of the environmental variability from selection lines may increase their variability, since if the controls (*c*) and selection lines (*s*) are independent, or $V_c > 2W_{cs}$, then $V_{c-s} > V_s$. (iv) Stability of genotype, in the sense that it is normally applied, cannot be considered a complete interpretation of the relative variability of inbred lines and their crosses. It remains of considerable interest to assess how much may be apportioned to this.

ALAN DURRANT

Department of Agricultural Botany,
University College of Wales,
Aberystwyth.
Nov. 23

---

[1] Gordon, C., and Sang, J. H., *Proc. Roy. Soc.*, B, **130**, 151 (1941).
[2] Robertson, F. W., and Sang, J. H., *Proc. Roy. Soc.*, B, **132**, 258 and 277 (1944).
[3] Mather, K., *Nature*, **174**, 304 (1954).
[4] Strong, L. C., edit., *Ann. N.Y. Acad. Sci.*, **57**, 451 (1954).
[5] Ashby, E., and Wangermann, E., *Ann. N.Y. Acad. Sci.*, **57**, 476 (1954).
[6] Lansing, A. I., *Ann. N.Y. Acad. Sci.*, **57**, 455 (1954).
[7] Jinks, J. L., *Nature*, **174**, 409 (1954).

The Covering Reaction in a Tropical Sea Urchin

IT has long been known that certain littoral echinoids habitually cover the parts of their body that are exposed to light by fragments taken from their surroundings. Some have interpreted this as a concealing reaction, or, in part at least, as a response to strong light, or as a defence against desiccation and temperature extremes resulting from exposure at low tide; others remained non-committal. *Lytechinus variegatus* (Lamarck) shows the response in striking fashion[1] and, in Jamaica, in habitats where it is never exposed by tides. The response has been examined in these laboratories.

The individuals found in Jamaica differ noticeably in the depth of the green colour of the test and spines, pale and dark forms being present in about equal numbers in the populations I have examined. Both avoid strong light (especially the pale forms), either by seeking shade or by covering themselves with opaque fragments; if the shade or the material available for cover is scanty, both methods are employed. Naked forms transferred from shade to sunlight may begin to cover themselves in about two minutes and complete the process in about five minutes. In intense sunlight, the process is continued until the urchin is buried in the hole excavated by the removal of stones, shells, etc., used to form the cover.

The response has been ascribed to the activities of tube feet and pedicellariæ[2], but I find no evidence of the latter taking part, each fragment being pulled down firmly against the tips of the spines by the tube feet attached to it. The number of tube feet involved depends on the weight of the object held, and if it is slightly displaced, additional tube feet are brought into play to hold it. These co-ordinated actions are still performed when the areas including the peristome or the periproct, and the lantern, together with all nerve elements associated with them, have been removed.

Light is a significant factor, since when it is directional, opaque objects are held against the source, and if the position of the latter is altered, the shading objects are moved accordingly. A shadow cast on the aboral or ambital regions produces a brief and rapid shortening of some tube feet, which then extend more slowly toward the shading object, adhere to it and hold it in the light path.

The covering is shed slowly and to varying degrees as the light intensity is reduced. In total darkness, a complete covering may be shed in 70 min.–3 hr., but in some cases, one or two stones have been retained for as long as 19 hr. When light is re-admitted, the covering is picked up again with a speed which depends on the light intensity, the time the urchin has remained in darkness and its depth of colour (pale individuals covering themselves more quickly and more completely than dark ones).

A process of physiological adaptation may occur; urchins which have been compelled to remain uncovered in strong light cease to show the response, but may show it again after a sojourn in darkness.

The importance of light is shown by the effect of dyes such as eosin *Y*, bengal rose and neutral red, which, when dissolved in sea water or cœlomic fluid and injected into the perivisceral cœlom, photosensitize urchins so that they cover themselves in relatively dim light. The effect appears in 2–20 hr. and persists for four to seven days.

The work is being continued and will be published in full elsewhere.

N. MILLOTT

Department of Zoology,
University College of the West Indies,
Jamaica.
Nov. 16.

---

[1] Boone, L., *Bull. Bingham Ocean. Coll.*, **1** (4), 1 (1925). Mortensen, Th., "Monograph of the Echinoidea", **3**, 2, Pt. 1, 433 (Copenhagen, 1943).
[2] Clark, H. L., "Scientific Survey of Porto Rico and the Virgin Islands", **16**, Pt. 1, 81 (New York Academy of Sciences, 1933).

Breeding Systems and Compatibility in *Glyceria*

A LIMITATION of gene exchange by incompatibility between segments of an outbreeding species-population is of primary importance in micro-evolution[1], and few cases have hitherto been reported in the Gramineae. Some results of a study of the species *Glyceria fluitans* and *Glyceria plicata* may therefore be of interest.

From both species, five widely separated local populations, each distinguished by minor morphological characters, were selected for intensive biosystematic investigation. Seed samples were collected by a suitable method[2], and the progeny grown in the experimental garden. All the plants had the somatic chromosome number $2n = 40$ usual in these species[3,4].

Table 1 BREEDING SYSTEMS AND COMPATIBILITY IN *Glyceria*

	G fluitans								*G plicata*							
	Selfed		Open pollinated*		Crosses within populations		Crosses between populations		Selfed		Open pollinated*		Crosses within populations*		Crosses between populations	
	Heavy†	Light‡	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light
Mean seed set (per cent)	27	46	67	19	62	16	1 2	2 5	81	6	84	4	76	12	75	9
Range (per cent)	8–58	13–67	65–71	6–23	51–75	12–19	0–9	0–10	69–97	4–9	81–86	2–6	68–81	7–17	70–81	6–12
Mean seed viability (per cent) (Heavy + light)	54		88		54		1 7		92		83		95		86	
Range (per cent)	2–90		87–90		50–58		0–21		82–100		65–97		90–100		80–95	

* Data from two populations only † Heavy seed grains of full size ‡ Light seed grains less than two-thirds full size

Tests were carried out to determine self- and cross-compatibility within and between populations. Hand emasculation followed by 'automatic pollination' was adopted in making crosses[5] Compatibility was assessed on the basis of seed-set and viability

A varying degree of self-incompatibility from plant to plant is characteristic of outbreeding grasses[6] Comparing the results obtained from selfing with those from uncontrolled outcrossing (Table 1), it can be seen that *G. fluitans* plants are to various extents self-incompatible This is shown by the low percentage of heavy seed obtained on selfing. Seed viability is related to degree of self-incompatibility, germination being poorest in the most self-sterile plants. *G plicata* plants are by contrast highly self-compatible

Observations were made of behaviour at anthesis. In *G fluitans* the florets opened briefly and the large pendulous anthers were fully exserted on long filaments prior to dehiscence, which occurred before the stigmas were fully expanded. The florets of *G plicata* stood open, and the small anthers were borne out on rather stiff filaments, dehiscing above the fully expanded stigmas. These facts strongly suggest that *G. fluitans* is a predominantly outbreeding species, and *G plicata* generally inbreeding In the latter species, though pollination is required for seed setting, apomixis may occur to some extent.

The results of controlled hybridization indicate that, in *G. plicata,* plants derived both from the same and different populations are highly cross-compatible By contrast, in *G fluitans* the results of intra- and inter-population crosses differ markedly

Seed set in intra-population crosses (62 per cent heavy seed) about equalled that obtained on outcrossing (67 per cent heavy seed), there was, however, some reduction in viability, 54 per cent as against 88 per cent on outcrossing.

In inter-population crosses, few or no seeds were set (1 2 per cent heavy seed) and the viability of these was poor (1 7 per cent)

This suggests that a degree of incompatibility exists between parts of the *G fluitans* species-population, sufficient to limit or prevent gene-exchange In both species the local populations sampled were distinct morphologically and perhaps equally well isolated from the micro-evolutionary point of view Incompatibility occurs in *G fluitans*, but is apparently absent from *G. plicata*, and this is probably related to the breeding systems of these species[7]

This work forms part of a biosystematic study of the British species of Sect. Euglyceria carried out at the University College of Leicester, the results of which will be given in full elsewhere.

MARTIN BORRILL

Grass Breeding Section,
Welsh Plant Breeding Station,
Aberystwyth.

Nov 29

---

[1] Clausen, J , "Stages in the Evolution of Plant Species" (New York, 1951)

[2] Gregor, J W , *New Phyt*, 35, 327 (1936)

[3] Church, G L , *Amer J Bot*, 36, 155 (1949)

[4] Fitzpatrick, J M , *New Phyt*, 45, 137 (1946)

[5] Jenkin, T J , Bull Welsh Plant Breed Stat , Ser H , No 2, 1 (1924)

[6] Jenkin, T J , Bull Welsh Plant Breed Stat , Ser H , No 12, 100 (1931)

[7] Baker, H G , *Evolution*, 6, 61 (1952)

Arginase in Elasmobranch Muscle

Hunter and Dauphinee[1] demonstrated the presence of arginase in the voluntary muscle of the dogfish (*Squalus sucklii*) and also possibly in the muscle of the herring In the course of another investigation, it has now been observed that this is not true of other elasmobranchs, since no arginase activity was found in the skeletal muscle of the common skate (*Raja batis*), thornback skate (*R clavata*) or cuckoo ray (*R circularis*) using the conditions of determination of Van Slyke and Archibald[2] with the colorimetric procedure of Engel and Engel[3]. Activity was, however, observed in both the ordinary 'white' skeletal muscle (0 3 arginase units[2]/mgm extract nitrogen) and 'red' lateral-band muscle (0 75 arginase units/mgm. extract nitrogen) of the lesser-spotted dogfish (*Scyliorhinus caniculus*) (cf the observations of Matsuura *et al*[4] on several non-elasmobranch species of fish).

It seems that for the rays, at least, the extra-hepatic regulation of urea which appears to occur in elasmobranchs cannot take place in the muscle, even though this tissue is rich in urea

J J. CONNELL

Torry Research Station
(Food Investigation Organization,
Department of Scientific and Industrial Research),
Aberdeen.

Dec. 2

---

[1] Hunter, A , and Dauphinee, J A , *Proc Roy Soc* , B, 97, 227 (1924)

[2] Van Slyke, D D , and Archibald, R M , *J Biol Chem* , 165, 293 (1946)

[3] Engel, M G , and Engel, F L , *J Biol Chem* , 167, 535 (1946)

[4] Matsuura, F , Baba, H J , and Mori, T , *Bull Jap Soc Sci Fish* , 19, 893 (1953)

FORTHCOMING EVENTS

Monday, March 28

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 6 p m —Major P L Teed "Fatigue" (Final Cantor Lecture on "The Mechanical Properties of Metals")

Tuesday, March 29

Aslib (at the Kingsley Hotel, Bloomsbury Way, London, W C 1), at 2 30 p m —Conference on "The Information Officer in Industry"

Tuesday, March 29—Thursday, March 31

Society of Chemical Industry, Northern Ireland Section and Food Group (in the Department of Geology, Queen's University, Elmwood Avenue, Belfast)—Joint Symposium on "Bacon".

Wednesday, March 30

Chemical Society (at the Royal Institution, Albemarle Street, London, W 1), at 10 30 a m —Symposium on "Peptide Chemistry"

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Sir Robert H Davis "Recent Developments in Deep Sea Diving"

Physical Society, Colour Group (at the Royal Photographic Society, 16 Princes Gate, Kensington, London, S W 7), at 3 15 p.m —Annual General Meeting 3 30 p m —Dr L C Thomson "The Part Played by Electrophysiology in the Investigation of Visual Mechanisms" (Chairman's Address)

Society of Chemical Industry, Corrosion Group (in the Convocation Hall of Church House, Westminster, London, S W 1), at 6 30 p m —Mr F L Laque "Attention to Corrosion in the U S A"

Royal Institute of Chemistry (joint meeting with the Chelsea Polytechnic Chemical Society, at the Chelsea Polytechnic, Manresa Road, London, S W 3), at 7 p m —Mr F V Davis "Man-made Textile Fibres"

Wednesday, March 30—Friday, April 1

Institute of Physics, X-Ray Analysis Group (at the University of Bristol, H H Wills Physical Laboratory, Royal Fort, Bristol 8)—Spring Conference

Thursday, March 31

Chemical Society (at the Royal Institution, Albemarle Street, London, W 1), at 11 a m —Dr Gunnar Randers (Norway) "The Outlook for Industrial Atomic Energy in Europe"

Institute of Refrigeration (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S W 1), at 5 30 p m —Symposium on "Modern Trends in the Storage of Fruit and Vegetables"

Institution of Electrical Engineers (at Savoy Place, London, W C 2), at 5 30 p m —Mr E W Golding "Electrical Energy from the Wind"

Royal Aeronautical Society (at 4 Hamilton Place, London, W 1), at 7 p m —Mr T D Weatherhead "Application of Aerial Survey to the Economic Development of a Country"

Thursday, March 31—Friday, April 1

Society of Chemical Industry, Corrosion Group (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 9 30 a m —Symposium on "The Protection of Structural Steel"

Thursday, March 31—Saturday, April 2

Physical Society (at the Atomic Energy Research Establishment, Harwell)—Spring Meeting—"Neutron Physics and Energy Levels"

Friday, April 1

Association of Applied Biologists (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S W 7), at 2 15 p m —Annual General Meeting, followed by Prof W Brown, F R S "The Physiology of Parasitism of Plants" (Presidential Address)

Friday, April 1—Sunday, April 3

Aslib Aeronautical Group (at the College of Aeronautics, Cranfield, Bletchley, Bucks)—Fourth Annual Conference

---

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer or Senior Lecturer in Mathematics, and a Lecturer or Senior Lecturer in Science, at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, Burlington Gardens, London, W 1, quoting 4434/55 (March 31)

Metallurgists (with a university degree or equivalent qualification in metallurgy, and preferably with experience in the behaviour of metals at high temperatures) in the Research Laboratories, British Electricity Authority, Leatherhead—Director of Establishments, B E A, Winsley Street, London, W 1, quoting AE 579 (March 31)

Biochemist (non-medical) in the Department of Chemical Pathology—The Secretary, Royal Free Hospital, London, W C 1 (April 1)

Senior Lecturer (with special qualifications in inorganic and analytical chemistry) in Chemistry, a Teacher of Chemistry, a Teacher of Science, and a Teacher of Mathematics—The Principal, College of Technology, Belfast, N Ireland (April 1)

Assistant Lecturer or Lecturer in the Department of Zoology—The Registrar, The University, Liverpool (April 2)

Organic Chemist (preferably with experience in the structural chemistry of natural products), to assist in the investigation of the structure of certain hormone-like substances of plant origin—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 55/5 (April 2)

Senior Lecturer (with at least an honours degree in metallurgy of a British university or equivalent, together with substantial experience in research or industry) in the Department of Metallurgy, to be responsible for teaching advanced physical metallurgy to honours B Sc (metallurgy) and A I M standards, and to participate in the postgraduate and research work of the Department—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (April 2)

Lecturer in Mechanical Engineering, at the College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff (April 5)

Principal Lecturer or Senior Lecturer in Radar and Telecommunications or Electronic Instrumentation, a Lecturer in Mechanical Engineering, a Lecturer in Electronics at the Royal Military College of Science, Shrivenham—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W 1, quoting S 4439/55 (April 7)

Assistant Veterinary Investigation Officer (Member of the Royal College of Veterinary Surgeons, and with experience of general veterinary practice among farm animals, and preferably with laboratory experience)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C 2 (April 9)

Experimental Officers and Assistant Experimental Officers (with at least H S C (science) or equivalent) at the Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants, for problems of combustion, heat transfer, aerodynamics, projects and performance instrumentation, and application of electronics in gas turbine research—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting C 146/5A (April 9)

Lecturer (preferably with research experience in polymer science) in Chemistry—The Registrar, The University, Manchester (April 9)

Lecturer (with experience in electron microscopy) in Biophysics—The Registrar, The University, Manchester 13 (April 11)

Lecturer (with a good degree in engineering and some industrial experience, and preferably some experience in engineering design) in the Department of Mechanical Engineering—The Registrar, The University, Liverpool (April 13)

Chair of Anatomy at the University College of Khartoum, Sudan—The Secretary, Inter-University Council, 1 Gordon Square, London, W C 1 (April 15)

Lecturer in Experimental Physics, Lecturers (2) in Electronics, Assistants in Experimental Physics, Theoretical Physics, and Electronics, and a Lecturer in Agriculture—The Secretary, The University, Aberdeen (April 15)

Director (with veterinary qualifications and preferably a good degree in science) of the Animal Health Trust Farm Livestock Research Station, Stock, Essex—The Scientific Director, Animal Health Trust, 14 Ashley Place, Westminster, London, S W 1 (April 18)

Physicists or Mechanical Engineers (with a good honours degree in physics or mechanical engineering, considerable experience in research, and with scientific originality and initiative), with the National Coal Board, Isleworth, Middlesex, to lead teams being formed for the investigation of the technical processes of coal winning—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/943 (April 18)

Lecturer or Assistant Lecturer (with a special interest in organic chemistry) in Chemistry—The Registrar, The University, Sheffield (April 23)

Assistant Lecturer in Mathematics—The Registrar, The University, Hull (April 25)

Chemist (with an honours degree in chemistry (biochemistry or agricultural chemistry) of a British university, and some research experience)—The Director, Tea Research Institute of East Africa, P O Box 91, Kericho, Kenya (April 30)

Lecturer (Grade I) in Chemical Engineering, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (April 30)

Lecturers in Experimental or Theoretical Physics—The Secretary of University Court, The University, Glasgow (April 30)

Assistant Lecturer in Physics—The Registrar, University College of North Staffordshire, Keele, Staffs (May 1)

Senior Lecturer in Plant Taxonomy, at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (May 10)

Assistant, Grade "B" (with graduate or A R I C qualifications) in Chemistry—The Principal, Technical College, Queen Street South, Huddersfield

Assistant Lecturer (with special interests in plant pathology) in Agricultural Botany—The Bursar, Royal Agricultural College, Cirencester

Assistant Technical Secretary (male or female) (with a general science degree or equivalent qualification, and preferably with experience in metallurgical analysis, metallography or physical testing) in the Metallurgy Division at the Association's London offices—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1, quoting "Assistant Technical Secretary"

Graduate (with an honours degree in chemistry or metallurgy) to undertake research in the methods of preventing corrosion of iron and steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1, quoting "Corrosion"

Head (with appropriate academic and industrial qualifications) of the Department of Chemistry and Biology, College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff

Laboratory Technician (with some knowledge of chemistry and experience in general workshop practice) whose main duties will be to take charge of Metallurgical Stores, and to prepare samples for laboratory classes—The Registrar, The University, Nottingham

Laboratory Technician (with general and chemical laboratory experience, and preferably some botanical experience)—Professor of Botany, The University, Edgbaston, Birmingham 15

Lecturer (with a good honours degree in metallurgy and preferably works experience) in Metallurgy—The Registrar, The University, Nottingham

Lecturers (2) in Mathematics—The Secretary, Royal Technical College, Glasgow

Senior Lecturer (specializing in stratigraphy–palæontology) in Geology—The Dean, College of Arts and Science, Baghdad, Iraq

Chair of Physics, and Chair of General Chemistry, at the Royal College of Medicine, Baghdad, Iraq—The Director, Personnel Department, The British Council, 65 Davies Street, London, W 1

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London Series A Mathematical and Physical Sciences No 929, Vol 247 (28 December 1954) Two-Dimensional Theory of Elasticity for Finite Deformations By J E Adkins, A E Green and G C Nicholas Pp 279–306 8*s* 6*d* No 930, Vol 247 (28 December 1954) The Asymptotic Solution of Linear Differential Equations of the Second Order for Large Values of a Parameter By F W J Olver The Asymptotic Expansion of Bessel Functions of Large Order By F W J Olver Pp 307–368 19*s* (London Royal Society, 1954) [3112

Papers of the Royal Commission on Population Vol 6 The Trend and Pattern of Fertility in Great Britain—a Report on the Family Census of 1946 By D V Glass and E Grebenik Part 1 Report Pp iii+306 Part 2 Tables Pp iv+253 (London H M Stationery Office, 1954) 70*s* net the two parts [3112

Institution of Gas Engineers Publication No 450 Origins and Development of Gas for Industrial Purposes By Dr Alexander Fleck (Murdoch Memorial Lecture) Pp 26 Publication 452 15th Report of the Chairman's Technical Committee, 1953–54 Pp 16 Publication No 453 Sixth Arthur Duckham Research Fellowship Report, 1953–54 Luminous Flame Radiation in a Smallscale Oil-fired Furnace By E P Hotchen Pp 54 Publication 454 31st Report of the Gas Education Committee, 1953–54 Pp 29 Publication 457 The Production of Town Gas by the Catalytic Gasification of Petroleum Oils 2 The Development and Operation of a Commercial Plant By H Stanier and J B McKean Pp 30 Publication 458 Disposal of Products of Combustion from Gas Appliances By A R Bennett and H Reichert Pp 37 (London Institution of Gas Engineers, 1954) [31

Federation of British Industries Public School and Grammar School boys in Industry Pp 12 (London Federation of British Industries, 1954) 1*s* [31

Ministry of Food Food Standards Committee Report on Colouring Matters, Recommendations relating to the Use of Colouring Matters in Foods Pp 27 (London H M Stationery Office, 1954) 1*s* net [31

Modern Storage Equipment and Methods for Special Materials in Libraries By Robert L Collison Pp 32 (London R L Collison, 7A, Worsley Road, N W 3, 1955) 2*s* 6*d* [31

Proceedings of the Royal Irish Academy Vol 56, Section A, No 5 Production and Annihilation of Negative Protons—3 By the Rev James McConnell Pp 45–66 3*s* 6*d* Vol 56, Section B, No 4 Records from some Irish Lakes Part 1 Mollusca, *Gammarus*, *Asellus*, Ephemeroptera, and Heteroptera Part 2 Phytoplankton By T T Macan and J W G Lund Pp 135–158 4*s* Vol 56, Section B, No 5 The Geology of the Northern End of the Leinster Granite Part 1 Internal Structural Features By J C Brindley Pp 159–190+plates 5–7 4*s* 6*d* (Dublin Hodges, Figgis and Co, Ltd, 1954) [31

Federation of British Industries Fuel Economy Review, 1955 Pp 100 (London Federation of British Industries, 1955) 5*s* [31

Hull Bulletins of Marine Ecology Vol 3, No 24 Continuous Plankton Records The Young Fish and Fish Eggs, 1932–39 and 1946–49 By Dr G T D Henderson Pp 215–252+plates 20–27 12*s* 6*d* Bulletins of Marine Ecology (formerly Hull Bulletins of Marine Ecology) Vol 4, Nos 27 and 28 Continuous Plankton Records The Distribution of Lamellibranch Larvæ in the North Sea, 1950–51 By Dr C B Rees The Distribution of Echinoderm and Other Larvæ in the North Sea By Dr C B Rees Pp 21–67+plates 7–12 12*s* (Edinburgh Scottish Marine Biological Association, 1954) [31

Philosophical Transactions of the Royal Society of London Series B Biological Sciences No 654, Vol 238 (31 December 1954) Observations on the Cytology and Taxonomy of the Pteridophyte Flora of Ceylon By Irene Manton and W A Sledge Pp 127–186+plates 3–14 40*s* No 655, Vol 238 (31 December 1954) Sensitivity to Light and the Reactions to Changes in Light Intensity of the Echinoid *Diadema antillarum* Philippi By N Millott Pp 187–220+plates 15 and 16 14*s* (London Royal Society, 1954) [31

Observations Made at the Royal Observatory, Greenwich, in the year 1939, in Astronomy, Magnetism and Meteorology, under the direction of Sir H Spencer Jones Pp vii+405+12 plates (London H M Stationery Office, 1953) 90*s* net [31

Building Research Station Digest No 72 Questions and Answers, with further Notes on Emulsion Paints Pp 4 (London H M Stationery Office, 1954.) 3*d* net [71

Electricity for Industry · Evidence on the Working of the Electricity Supply Industry, 26 October 1954 Pp 10 (London Federation of British Industries, 1954) 1*s* [71

Other Countries

Hong Kong University Fisheries Journal No 1 (December 1954) Pp iv+65+12 plates (Hong Kong Hong Kong University Press, 1954) [3112

Canada Department of Northern Affairs and National Resources National Museum of Canada Bulletin No 132 Annual Report of the National Museum of Canada for the fiscal year 1952–53 Pp iv+313 (18 plates). (Ottawa Queen's Printer, 1954) 1 50 dollars [3112

English Version of Introduction and Remarks from the Fifth Supplement to the First Edition of the General Catalogue of Variable Stars (by B V Kukarkin, P P Parenago, Yu I Efremov and P N Kholopov, Moscow, 1953), containing information about 70 Variable Stars which were newly named during 1953, and also more precise information about 324 previously named Variable Stars, and from the Sixth Supplement to the First Edition of the General Catalogue of Variable Stars (by B V Kukarkin, P P Parenago, Yu I Efremow and P N Kholopov, Moscow, 1954), containing information about 285 Variable Stars which were newly named during 1954, and also more precise information about 343 previously named Variable Stars Pp 35 (Leiden International Astronomical Union, 1954) [3112

Federation of Malaya Annual Report of the Department of Agriculture for the year 1953 By O J Voelcker Pp viii+60+5 plates (Kuala Lumpur Government Printer, 1954) 2 dollars, 4*s* 8*d* [3112

New Zealand Forest Service Annual Report of the Director of Forestry—1 April 1953 to 31 March 1954 Pp 99 (Wellington Government Printer, 1954) [3112

Centro Brasileiro de Pesquisas Fisicas Notas de Fisica No 15 Quantum Theory of the Emission Process By Guido Beck Pp 13 Notas de Fisica No 17 The Harmonic Mean Energy for Photon Absorption by Nuclei By J Goldemberg and J Leite Lopes Pp 4 (Rio de Janeiro Centro Brasileiro de Pesquisas Fisicas, 1954) [3112

Nyasaland Protectorate Annual Report of the Geological Survey Department for the year ended 31st December, 1953 Pp 26 (Zomba Government Printer, 1954) [31

Chicago Natural History Museum Fieldiana Botany Vol 29, No 1 Revision of the Genus Cheirosendron Nutt Ex Seem, for the Hawaiian Islands By Earl Edward Sherff Pp 45 (Publication 739) (Chicago Chicago Natural History Museum, 1954) 75 cents [31

Fiskeridirektoratets Skrifter Serie Havundersøkelser (Reports on Norwegian Fishery and Marine Investigations) Vol 11, No 2 Undersøkelser over torsken i Oslofjorden Av Finn Otterbech Pp 17 (Bergen A s John Greigs Boktrykkeri, 1954) [31

Annals of the New York Academy of Sciences Vol 58, Art 7 Tissue Culture Technique in Pharmacology By C. M Pomerat, Elmer L Sevringhaus and 48 other Authors Pp 971–1326 Vol 59, Art 2 Paul Ehrlich Centennial By Robert J Schnitzer, E Grunberg and 11 other Authors (New York New York Academy of Sciences, 1954) [31

l'Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture (I R S I A) Comptes Rendus de Recherches No 13 (December 1954) Travaux du Comité pour l'Étude des Maladies et de l'Alimentation du Bétail Pathogenese, Diagnose en Behandeling van de Trichomonas-infektie bij Runderen Door Dr M Vandeplassche, Dr A Florent, Dr F Paredis, and Dr E Brone (Bruxelles l'Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1954) 80 francs [31

Flora of Egypt Vol 3 Angiosperme, part Monocotyledones Liliaceae—Musaceae By Dr Vivi Tackholm and Mohammed Drar (Bulletin of the Faculty of Science No 30) Pp xiii+644 (Cairo Cairo University Press, 1954) [31

International Journal of Abstracts on Statistical Methods in Industry Vol 1, No 1 (1954) Pp viii+39 Annual subscription (3 issues) 9 50 guilders, 18*s*, 2 50 dollars Single issues 3 80 guilders, 7*s* 3*d*, 1 dollar (The Hague International Statistical Institute, 1954) [71

Smithsonian Miscellaneous Collections Vol 123, No 4 Revision of the Flea Genus Peromyscopsylla By Phyllis T Johnson and Robert Traub (Publication 4178) Pp ii+68 (Washington, D C Smithsonian Institution, 1954) [71

Catalogues

A Gallenkamp and Co, Ltd Revised Price List and Addenda for 12th Edition Catalogue Vol 1 General Section Pp 162 (London A Gallenkamp and Co, Ltd, 1954)

W Watson and Sons, Ltd Metallurgical Microscopes Pp 14 (London W Watson and Sons, Ltd, 1954)

Cambridge Instrument Company, Ltd Sheet No 321 Cambridge Electronic Recorder Pp 4 (London and Cambridge Cambridge Instrument Company, Ltd, 1954)

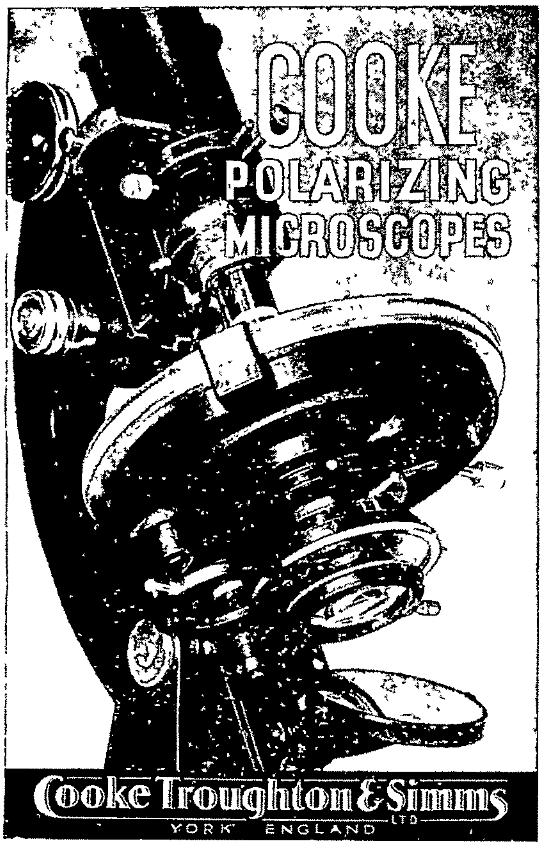
Solus-Schall Limited Leaflet No 31 Magnetic Wall Thickness Gauge Pp 4 (London Solus-Schall, Ltd, 1954)

Rocke International, Ltd "Short Catalog" (Brüel and Kjaer, Denmark) Instruments for Electrical, Acoustical, Radioactive, Vibrational, Strain Gauge, Electro Chemical Measurements Pp 14 (London Rocke International, Ltd, 1954)

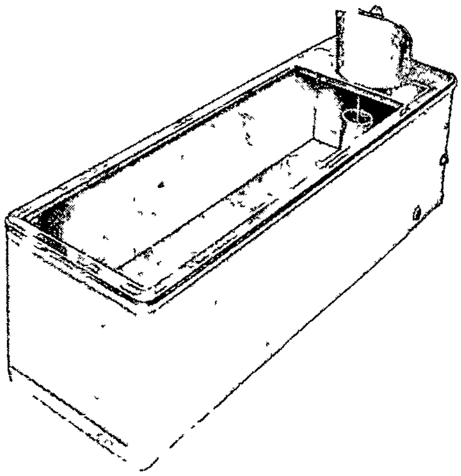
The American Library Recent Additions Pp 36 (London American Library, 41 Grosvenor Square, 1954)

Henry Wiggin and Co, Ltd Data Sheet—Monel Pp 3 (London Henry Wiggin and Co, Ltd, 1954)

Hilger and Watts, Ltd Polarimeters (CH 242/7) Pp 12 Recording X-ray Diffractometer (CH 322/3) Pp 12 Three-Metre Grating Polychromator with Direct Photoelectric Recording of Spectrum Line Intensity (CH 385) Pp 9+3 plates Accessories for Infra Red Spectrophotometry (CH 388/R.) Pp 5+2 plates Arc and Spark Stands and Source Units for Spectrochemical Analysis (CH 387) Pp 11+4 plates New Hilger Spekker Photoelectric Fluorimeter (Ch 390) Pp 4 Hilger Inspection Enlargers (CT 430/2) Pp 10 Hilger Production Projectors for Routine Inspection and for Filing Gauges (CT 420/4) Pp 12 (London Hilger and Watts, Ltd, 1954)



"CUSTOM BUILT" THERMOSTATIC BATH



The Standard L T E Baths are designed to have the widest range of applications and are available in four sizes Temperature ranges from room temperature or slightly below, using the cooling unit, to 100° C Deviation from the desired mean temperature is within 0 5° C Sensitive temperature control ensures adequate performance under all conditions Racks and fittings are available for all the standard tests and "Custom Built" racks and fittings are made to specifications

Please send for illustrated catalogue to—

LABORATORY THERMAL EQUIPMENT LTD

GREENFIELD, Nr Oldham, England Tel Saddleworth 552

The Policy for Education

provides a means of saving for a child's education For example, for a parent aged 35 next birthday,

The Society pays

£100 p.a. for 5 years, beginning in 15 years' time,
and
if the parent dies within 15 years, £100 p a in the meantime towards the child's maintenance

The cost is

£8 7s 6d a quarter for 15 years at most.

Enquire for details, giving the ages of parent and child.

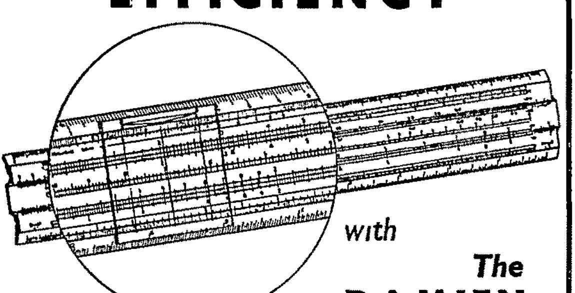
The Equitable Life Assurance Society

(founded 1762)

19, Coleman Street, London, E C 2

No shareholders No commission.

SLIDE RULE EFFICIENCY



with

The DAMIEN METAL SLIDE RULE

Light . . unbreakable . . never wears out . . . indifferent to atmospheric or other conditions. Photographic printing ensures absolute accuracy, while the silver-grey finish gives figures maximum legibility. Retail price £3 3s. 0d. each.

SPECIAL REDUCED PRICES FOR OVERSEAS

Obtainable from leading stationers and Drawing Office suppliers or direct from

ANODISED PRODUCTS Ltd.

91 Upper Thames Street, London, E.C.4

Telephone. MAN 7765

LECTURES AND COURSES

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

ACTON TECHNICAL COLLEGE
HIGH STREET, ACTON, W 3
Principal J Topping, M Sc , Ph D , F R I C , D I C

DEPARTMENT OF CHEMISTRY AND BIOLOGY
Head of Department J H Skellon, T D , M Sc , Ph D , F R I C

The following Special Courses will be held during the Summer Term 1955 (1) Production and Utilization of Glyceride Oils and Fats Fridays, April 22 to July 18, 1955 7 30 p m Lecturer, Dr J H Skellon F R I C To include Survey of important natural fats Fat utilization Methods of extraction and refining Fat structure and its bearing on utilization Edible oils and fats Special uses Fats in the soap industry Oils in the paint and varnish industry The course is intended for industrial chemists, research workers and others engaged in industries utilizing oils and fats and related compounds Fee for the Course, £2 2s (2) A special three-day Laboratory Course on Paper Chromatography Wednesday, Thursday, Friday, April 13 14 15, 1955 Lecturer, I Smith Esq , B Sc , A R I C To include Experiments in ascending, descending and circular paper chromatography Types of paper Location reagents Comparison of spray, dip and other methods of applying reagents to chromatograms Multiple dipping procedures Desalting techniques, etc Special applications in the organic and biochemical field Suitable for industrial chemists and analysts wishing to acquire training in new analytical techniques Fee for the course, £2 2s

Further particulars and forms of application may be obtained from the Principal

C E GURR
Secretary to the Education Committee

SIR JOHN CASS COLLEGE

JEWRY STREET, LONDON, E C 3
Telephone No ROYal 3383

The College prepares students by full-time, by part-time day and evening courses in Botany, Physics, Mathematics, Geology Chemistry, Zoology for the intermediate examination and the B Sc general degree of the University of London for internal and external students and for the examinations of the Royal Institute of Chemistry, of the Institution of Metallurgists, and of the Institute of Physics Full-time and part-time courses are also held for the B Sc internal and external special degrees in chemistry, in mathematics and in physics, and for the B Sc (Eng) metallurgy degree There are full-time courses for the London external special degrees in botany and in zoology Facilities are provided for research and postgraduate study and short courses of lectures are held on a variety of special topics Research Assistantships (£350 per annum) will be awarded in September, 1955 About six Bursaries, each of £40 per annum, are available to students in attendance at the college

Applications for enrolment for the Academic Year 1955-56 may now be made on forms to be obtained from the Secretary

---

COLLEGE OF AERONAUTICS

The Board of Entry of the College invites applications from suitable candidates for the two-year course which begins in October, 1955, and ends in June, 1957 Candidates should be of graduate standard, although the possession of a degree is not essential , a good higher national certificate is an acceptable standard The College, a postgraduate institution, is devoted to the study of aeronautical science and engineering The curriculum covers the five main subjects of Aerodynamics, Aircraft Design, Aircraft Electrical Engineering Aircraft Propulsion and Aircraft Economics and Production Instruction in the first year is designed to provide all students with a broad background of knowledge in all these subjects, with opportunity for limited specialization in two or three of them In the second year, students specialize more particularly, usually in one subject Experiments in the air are an important part of the work, both in the first year when all students take part in them and in the second year when they are linked to the specialist work of the departments Students who satisfactorily complete the course will receive the Diploma of the College

Further particulars and details of the procedure for enrolment may be obtained from The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks

---

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING

The following courses of ten lectures each will be given on Monday afternoons commencing April 25, 1955 "The Principles of Flame Structure, Shape and Stability in Flowing Gases" by Dr F J Weinberg "Combustion in Internal Combustion Engines" by Mr N P W Moore, Mechanical Engineering Department

Further particulars from the Deputy Registrar, City and Guilds College, Exhibition Road, London, S W 7

UNIVERSITY OF LONDON

A lecture on "Specific Inhibition of Adrenergic Responses" will be given by Professor Mark Nickerson (Manitoba) at 5 p m on March 30 at St Thomas's Hospital Medical School, Albert Embankment, S E 1

Admission free, without ticket

JAMES HENDERSON,
Academic Registrar

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 *to* 64 *inclusive, or a woman aged* 18 *to* 59 *inclusive unless he or she, or the employment is excepted from the provisions of the Notification of Vacancies Order,* 1952

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Lecturer in the Department of Mechanical Engineering The duties of the Lecturer will be mainly the teaching of Engineering Design and Drawing and candidates for the post should have a good degree in engineering and some industrial experience Experience in engineering design is desirable but not essential The initial salary will be within the range £650 to £1,350 per annum, according to qualifications and experience

Applications, stating age, qualifications and experience, together with the names of three referees, should be received not later than April 13, 1955, by the undersigned, from whom further particulars of the conditions of appointment may be obtained

STANLEY DUMBELL,
Registrar

UNIVERSITY OF ABERDEEN

Applications are invited for the following posts (1) In Department of Natural Philosophy Lectureship in Experimental Physics, salary scale (c) or (b) Two Lectureships in Electronics, one on salary scale (c) or (b), the second on salary scale (a) Revised salary scales (c) £1,350 to £1,550 per annum , (b) £950 to £1,350 per annum , (a) £650 to £950 per annum Assistantships in Experimental Physics, Theoretical Physics, and Electronics, on revised salary scale £550 to £650 per annum Appointment as Assistant renewable for three to five years, with possibility of appointment as Lecturer if vacancy occurs or if of exceptional merit (2) In Department of Agriculture Lectureship in Agriculture Qualifications required in Agricultural Engineering with special reference to farm equipment and surveying Salary on revised scale (a), £650 per annum rising to £950 per annum All posts carry F S S U and children's allowance , initial placing according to qualifications and experience , part of removal expenses refunded

Applications (eight copies for Lectureships two copies for Assistantships), should be lodged not later than April 15, 1955 with the undersigned from whom forms of application and conditions of appointment should be obtained Applicants outside the British Isles may submit one copy only

W S ANGUS
, Secretary
University of Aberdeen

UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for the post of Lecturer in Engineering, with special interests in fluid mechanics The appointment will date from October 1, 1955 Initial salary on the scale £650 by £50 to £1,350 per annum, according to qualifications and experience F S S U benefits and family allowances

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea to whom applications must be sent by April 30 1955

FOURAH BAY COLLEGE

SIERRA LEONE
(UNIVERSITY OF DURHAM)

Applications are invited for the post of Pr
pal, vacant on the retirement of Mr F R
M A The College was founded by the Ch
Missionary Society in 1827, affiliated to the
versity of Durham in 1876, and reorganize
1950 to provide for the association of techno
cal and commercial courses with its exi
B A (Gen) and B A (Econ) degree courses
Durham University and its teacher training
theological courses Further reorganization ta
place on the recommendations of a recent Ed
tion Commission will involve a new ap
science course and development towards a
gree course in pure science The successful
didate's qualifications may be in arts, scienc
technology, but must include a good hon
degree It is a statutory requirement that
the selection of the Principal due regard shal
paid to the Christian traditions of the Colle
The period of appointment is ten years in
first place (which qualifies the holder for a
contributory pension), and may be exten
Salary (gross), £2,300 per annum, including
patriation pay (£450) and cost of living allow
(£200) A rather higher salary might be consid
for a person with outstanding qualifications
experience Furnished house provided, rent
per annum Free first-class passages on ta
up and relinquishing post and for U K l
(normally annual) for person appointed, wife
up to three children under 10 (or an allowanc
£50 per annum for up to three children under

For further information, apply to Secret
Advisory Committee on Colonial Colleges
Gordon Square, London, W C 1 Closing
for applications (six copies), April 13, 1955

NOTTINGHAM AND DISTRIC TECHNICAL COLLEGE

Principal H Baker, Ph D , A M I C E , A M I Mech E

Applications are invited for the post of As
ant Grade B, in the Department of Mining
teach geology to general certificate of educa
advanced level and to higher national certifi
standard in the Mining and Mine Surve
courses A degree or equivalent qualificatio
mining or geology and practical experience in
coal mining industry is desirable Salary £52
£820 per annum, together with degree and t
ing allowances in appropriate cases

Further particulars and form of application
be obtained from the Registrar, Nottingham
District Technical College, Shakespeare St
Nottingham, to whom completed forms shoul
returned not later than April 14 1955

F STEPHENSO
Clerk to the Joint Education Commi

ROWETT RESEARCH INSTITU

Laboratory Assistant required to take ch
of the preparation of bacteriological media in
Pathology Department The appointment wi
in the Assistant (Scientific) or Senior Assi
grade, according to age and experience A su
annuation scheme is in force Salary sca
Assistant, £252 10s (age 18) to £512 10s
annum , Senior Assistant, £545 to £745 per an
The scales for women are slightly lower

Applications, stating date of birth with
ticulars of education and experience, should
sent to the Secretary, Rowett Research Insti
Bucksburn, Aberdeenshire, as soon as possib

CENTRAL RESEARCH ESTABLISHME
National Coal Board (at Isleworth Middle
invite applications for the superannuable app
ment of a Physicist or Mechanical Enginee
carry out research concerned with the design
development of mechanical and electro-mecha
instruments required for mining research, inclu
certain aspects of health and safety This
will be carried out initially in the laboratory,
though confirmation of the behaviour of eq
ment in pit conditions is an essential feat
Candidates should have a good honours de
in physics or mechanical engineering, or equ
ent professional qualifications and some ex
ence in research and practice in the instrun
field Appointment will be according to quali
tions and experience as Scientist II (scale £85
£1,232 inclusive, male, and £750 to £1,070 in
sive, female) or Scientist III (scale £534 to £1
inclusive, male, and £509 to £893 inclusive,
male) —Write, giving full particulars (in chr
logical order) of age, education, qualifications
experience (with dates), to National Coal Bo
Establishments (Personnel), Hobart House, G
venor Place, London, S W 1, marking envel
TT/944 Original testimonials should not be
warded Closing date April 20, 1955

›MMONWEALTH of AUSTRALIA

COMMONWEALTH SCIENTIFIC AND
[DUSTRIAL RESEARCH ORGANIZATION

'he Commonwealth Scientific and Industrial earch Organization invites applications for ap- itment to positions as Research Officer or ior Research Officer in the Coal Research Sec- ., Sydney, New South Wales, details of which given below Position No 480/150 Duties, indertake investigations of the chemical struc- of Australian coals and assessment of their ential value to the chemical industry, and, in ticular, to examine the behaviour of the coals various chemical reactions such as hydrogeno- ; or to study the chemical reactions occurring ing the pyrolysis of coals Qualifications, uni- ity honours degree in science, with chemistry major subject and physics to a high standard erience in the chemistry of natural or poly- ic substances would be an advantage Posi- No 480/153 Duties, To participate in the vities of a group concerned with the studying the mechanical properties of coal and their ustrial significance This work involves a damental study of coal strength and breaking cesses Qualifications, university honours de- : in science, with physics or mathematics as or subjects or engineering Additional post- duate research experience would be an ad- tage Position No 480/154 Duties, to ticipate in studies being undertaken to evalu- combustion characteristics of Australian coals : group concerned is undertaking fundamental lies of combustion processes, clinkering :nomena, and the burning of coal in suspension l in model fuel beds Qualifications, university iours degree in science or fuel technology :ther postgraduate research experience would an advantage Salary Dependent on qualifica- is and experience, commencing salary will be ermined within the range of Senior Research icer, £A 1,814 to £A 2,078 per annum, £A 42 rements, subject to efficiency review at £A 1,898 : annum, or Research Officer, £A 1,184 to 1 730 per annum, thirteen increments subject efficiency review at £A 1 268 and £A 1,520 per num Fare to Australia (including those of wife l family) will be paid The appointment is ject to a satisfactory medical examination and : appointee may be granted superannuation vileges

Applications, referring to the appropriate ap- intment No and stating full name, place, date l year of birth, marital state, nationality, :sent employment, particulars of qualifications l experience, and of war service, if any, accom- ied by the names and addresses of two persons ling to act as referees, if required, and copies not more than four testimonials, should reach : undersigned not later than April 30, 1955

W IVES,
Chief Scientific Liaison Officer
stralian Scientific Liaison Office,
Africa House,
Kingsway, London, W C 2

I M OVERSEA CIVIL SERVICE

Applications are invited for the following post 'estock Officer, Veterinary Department, Nyasa- id , Duties connected with development of the al animal industry, mainly in African areas ndidates must possess a university degree either dairy husbandry or in agriculture with special- tion in animal husbandry, and some experience stock management Appointment on probation the permanent and pensionable establishment in salary scale £625 to £1,515 a year, plus a non- isionable cost of living allowance of between) to £195 10s a year Outfit allowance of £30 initial salary is £975 a year or less Free pas- ies for officer and wife and up to one full fare children on appointment and leave Govern- nt quarters when available at moderate rental xation at local rates

Apply, giving brief particulars to the Director Recruitment, Colonial Office, Sanctuary Build- s, Great Smith Street, London S W 1, quoting erence BCD 67/4/03

IPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Lecturer in Chemical Physics of Solids required the Department of Chemical Engineering tober, 1955, or as soon as possible thereafter lary £700 by £50 to £1,000, by £50 to £1,400, 'h F S S U and family allowances Applicants uld have had special experience of *X*-ray 'stallography

Four copies of application, together with names not more than three referees, should be sent the Head of the Department of Chemical En- ieering Imperial College, London, S W 7 (from iom further particulars may be obtained), not er than April 25

UNIVERSITY OF CAMBRIDGE

SCHOOL OF AGRICULTURE

Applications are invited for the post of University Lecturer in Field Experimentation Applicants should possess an honours degree and also appropriate qualifications in agriculture and should have had experience of research and teaching in field experimentation The pensionable stipends of university teaching officers are under review, but the current scale is £750, rising by annual increments of £50 to £1,250 The stipend may be supplemented by a pensionable payment not exceeding £120 on fulfilment of certain conditions A non-pensionable allowance of £50 a year is paid in respect of each dependent child under the age of 16 or in receipt of full-time education

Applications, setting out qualifications and experience, together with the names of not more than three referees, should be sent to the Secretary, School of Agriculture, Downing Street Cambridge, so as to reach him not later than April 13

UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for either an Assistant Lectureship or a Lectureship in the Department of Chemistry Candidates should be physical chemists with special interests in infra-red spectroscopy Salary scales Assistant Lecturer £450 by £50 to £550 per annum, Lecturer £550 by £50 to £1,100 per annum Salary scales under review Commencing salary in each case will be at a point on the appropriate scale according to qualifications and experience Membership of F S S U and children's allowance scheme

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, to whom applications must be sent by Wednesday April 6 1955

UNIVERSITY OF GLASGOW

LECTURESHIPS IN EXPERIMENTAL OR THEORETICAL PHYSICS

Applications are invited for Lectureships in Experimental or Theoretical Physics Salary scale Lecturer, £650 by £50 to £1,350, Senior Lecturer, £1,400 by £50 to £1,650 Grade of appointment and initial salary according to experience and qualifications F S S U and family allowance benefits Successful applicants will be expected to prosecute experimental or theoretical research in nuclear physics in addition to teaching duties

Applications (five copies) including the names of two referees, should be lodged not later than April 30, 1955, with the undersigned from whom further particulars may be obtained

ROBT T HUTCHESON,
Secretary of University Court

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Lecturer in Chemistry Preference will be given to candidates with research experience in polymer science Salary on a scale £650 by £50 to £1 350 per annum, initial salary according to qualifications and experience Membership of F S S U and children's allowance scheme

Applications should be sent not later than April 9, 1955, to the Registrar, the University, Manchester, 13, from whom forms of application and further particulars may be obtained

---

IMPERIAL COLLEGE

DEPARTMENT OF ELECTRICAL ENGINEERING

Applications are invited for two Lectureships from October 1, 1955 Candidates should possess a good honours degree in electrical engineering and preferably have completed a graduate apprenticeship or have had similar industrial experience Salary within range £700 by £50 to £1,000 and upwards according to qualifications and experience, with F S S U and family allowances Duties will include undergraduate and postgraduate teaching and the undertaking of research

Applications stating age, academic qualifications and experience, with the names of two referees, should reach the Head of Department, Imperial College, London, S W 7, by April 18, 1955

ANIMAL HEALTH TRUST

Applications are invited for the post of Director of the Trust's Farm Livestock Research Station, which is being developed at Stock, Essex Veterinary qualifications essential good degree in science desirable Salary within the range £1 750 by £100 to £2,250 per annum Federated Superannuation System for Universities

Further particulars from the Scientific Director, The Animal Health Trust, 14 Ashley Place, Westminster, London, S W 1 Latest date for receipt of applications, April 18, 1955

ROYAL MILITARY COLLEGE OF SCIENCE

SHRIVENHAM, BERKSHIRE

The Civil Service Commissioners invite applications from men for the following posts under the War Department (a) One Principal Lecturer or Senior Lecturer (according to age and qualifications), radar and telecommunications or electronic instrumentation (b) One Lecturer, mechanical engineering (c) One Lecturer, electronics (d) A number of posts, normally tenable for three years, as Demonstrators in Physics or Mechanical Engineering or Electronics or Electrical Engineering or Instrumentation All posts are unestablished, but candidates appointed to posts (a) to (c) will be considered for establishment (i e, pensionable) posts as they occur and unestablished service will, subject to the normal rules, count for superannuation purposes under the Superannuation Acts (which also provide gratuity for unestablished service lasting for more than seven years) For posts (d) provision made under F S S U Teaching work is at university level and candidates must have (or obtain in Summer, 1955) an appropriate degree (at least second-class honours) or equivalent Research, for which there are excellent facilities, is encouraged Particular qualifications required as follows For post (a) experience in research, design or teaching in at least one of radar, telecommunications, missile guidance and electronic instrumentation For (b), qualifications in applied thermodynamics For post (c) specialized knowledge of either electronics or telecommunications Age For post (a) at least 31 on January 1, 1955, for Principal Lecturer or 26 on that date for Senior Lecturer For other posts, at least 21 and under 28 on that date, with extension for regular Forces service and for permanent service in the Experimental Officer class Inclusive salaries Post (a) £1,125 to £1 507 (Principal Lecturer) or £970 to £1,125 (Senior Lecturer), posts (b) and (c) £467 10s to £845, posts (d) £487 10s to £615 In assessing starting salaries for posts (b) and (c) credit will be given for approved postgraduate experience and National Service, but will not exceed, for example, £630 at age 25 or £792 10s at age 30 Consideration according to circumstances will be given for posts (a) and (d) Secondment from, and transfer to, Scientific Civil Service may be arranged The College is residential, houses available at economic rents for married men and quarters in residential officers' mess at very reasonable charges for single men Successful candidates to take up duty in October, 1955, or as soon as possible ,

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W 1, quoting No S4439/55 Application forms must be returned by April 7, 1955

UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for a Lecturer (Grade II) in Civil Engineering Salary within the range of £650 to £1,350 (efficiency bar at £900), plus F S S U and family allowance benefits Duties to commence October 1 1955 Applicants should have a good general knowledge of civil engineering subjects, preferably in structural reinforced concrete or hydraulics and have had some practical experience Time and facilities will be available for research work

Three copies of applications, together with the names of three referees, should be forwarded to the Registrar by April 23 Further particulars may be obtained from the undersigned

G L BARNES,
Secretary

The University,
Birmingham, 15

UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for the post of Lecturer in Metal Physics in the Department of Physics The appointment will date from October 1, 1955 Initial salary on the scale £650 by £50 to £1,350 per annum, according to qualifications and experience F S S U benefits and family allowances

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, to whom applications must be sent by April 30, 1955

UNIVERSITY OF HULL

Applications are invited for the post of Assistant Lecturer in Mathematics Salary £550 to £650 per annum, with F S S U and children's allowances

Further particulars may be obtained from the Registrar with whom applications (five copies) must be lodged not later than April 25, 1955

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

LECTURER OR ASSISTANT LECTURER IN ELECTRICAL ENGINEERING

The Governing Body invites applications for a Lectureship or an Assistant Lectureship in Electrical Engineering in the College of Technology, with the title and status of Lecturer or Assistant Lecturer in the University of Manchester The Department covers a very wide range of aspects of electrical engineering, and all members of staff are expected to undertake, assist in or supervise research Salary Lecturer, £650 per annum, rising by annual increments of £50 to £1,350 per annum Assistant Lecturer, £550 per annum, rising by annual increments of £50 to £650 per annum Commencing salary according to qualifications Superannuation under F S S U and family allowances

Conditions of appointment and form of application may be obtained from the Registrar College of Technology, Manchester, 1 The last day for the receipt of applications is April 30, 1955

B V BOWDEN,
Principal of the College

UNIVERSITY COLLEGE OF NORTH STAFFORDSHIRE

Applications are invited for the post of Assistant Lecturer in Physics Salary in the scale £600 by £25 to £650 per annum, with F S S U and children's allowances

Application forms, in duplicate, should reach the Registrar, The College, Keele, Staffs, from whom further particulars and application forms may be obtained, not later than May 1, 1955

NATIONAL COAL BOARD

N W DIVISION

Chemist required at the Central Laboratory, Shade House, Pendlebury, Manchester Should possess degree in chemistry or equivalent qualifications Must have sound knowledge of modern instrument techniques, be experienced in investigational and research work and have ability to lead small research group Salary within scale £500 by £25 to £950 per annum

Applications, giving age, education, qualifications and experience to Establishment Officer, 40 Portland Street, Manchester, 1, within fourteen days

---

UNIVERSITY OF LEEDS

DEPARTMENT OF COAL GAS AND FUEL INDUSTRIES WITH METALLURGY AND CHEMICAL ENGINEERING

The Council invites applications for four posts in the Department in chemical engineering, in gas engineering and in fuel technology Appointments will be made on the Lecturer scale and on the Assistant Lecturer scale (both at present under review)

Applications (three copies), stating date of birth, qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained), not later than April 30, 1955

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Lecturer in the Department of Bacteriology A medical qualification is not essential The initial salary will be within the range £650 to £1,200 per annum, according to qualifications and experience

Applications, stating age, qualifications and experience, together with the names of three referees, should be received not later than April 15, 1955, by the undersigned, from whom further particulars of the conditions of appointment may be obtained

STANLEY DUMBELL,
Registrar

UNIVERSITY OF LIVERPOOL

Applications are invited for a Leverhulme Postgraduate Fellowship in any Department of the Faculty of Engineering (which includes the Department of Metallurgy) The Fellowship will be tenable for one year at a value of £500, but may be renewed for a second year at a value of £550

Applications, stating age, experience and qualifications, proposed field of research and the names of two referees, should be received not later than May 1 1955, by the undersigned from whom further particulars may be obtained

STANLEY DUMBELL
Registrar

COMMONWEALTH of AUSTRALIA

APPOINTMENT NO 201/74—VETERINARY BACTERIOLOGIST

The Commonwealth Scientific and Industrial Research Organization invites applications for appointment to a position of Senior Research Officer or Research Officer at its Animal Health Research Laboratory, Parkville, Victoria Duties To undertake research work on aspects of bovine contagious pleuropneumonia If necessary, knowledge of the disease may first be gained by participation of the current work of the Section Qualifications University degree in veterinary science with postgraduate research experience in bacteriology or immunology, or equivalent qualifications Salary Commencing salary will be determined within the range of Senior Research Officer, £A 1 814 to £A 2,078 per annum, £A 42 increments , or Research Officer, £A 1,184 to £A 1,730 per annum, thirteen increments, subject to efficiency review at £A 1,268 and £A 1,520 per annum Fares to Australia (including those of wife and family) will be paid Subject to satisfactory medical examination the appointee may be granted superannuation privileges

Applications, referring to Appointment 201/74, and stating full name, place and date of birth nationality, marital state, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by names and addresses of at least two persons willing to act as referees, if so required, and copies of not more than four testimonials should reach the undersigned not later than April 23, 1955

W IVES
Chief Scientific Liaison Officer

Australian Scientific Liaison Office,
Africa House,
Kingsway, London, W C 2

STOCKPORT COLLEGE FOR FURTHER EDUCATION

Applications are invited for the following posts for full-time Teachers in the College, duties to begin on September 1, 1955 Burnham Technical Salary Scale N J C conditions Lecturer to teach Organic Chemistry Good honours degree and preferably Corporate Membership of the R I C , to assist with advanced work Assistant Lecturer Grade B in Biology Good honours degree in botany and ability to teach advanced work

Application forms and further particulars from the Principal, Stockport College, Wellington Road South, Stockport, to be returned to him by April 1 1955

LONDON COUNTY COUNCIL

Norwood Technical College September, 1955, Grade B, for Department of Chemistry and Biology Should possess honours degree in chemistry, and able to teach physical chemistry to B Sc , general degree level Teaching experience, industrial or research experience desirable Burnham F E salary scale man, £621 by £25 to £1 012 , woman, £566 3s to £1 012 Individual minimum and maximum, according to age, qualifications and experience

Application forms from Principal at College, Knights Hill, West Norwood, S E 27, returnable by April 8 (338)

WALSALL HOSPITAL MANAGEMENT COMMITTEE

BIOCHEMIST (BASIC GRADE)

Applications for the above vacancy from holders of science degree or A R I C diploma, together with names of two referees, should be sent to the Group Secretary, Walsall General Hospital, Staffs

---

BIOCHEMIST (BASIC GRADE) REQUIRED to work in the Biochemistry section of the Pathology Department The work entails routine analysis, and assisting in research projects in the hospital Salary and conditions in accordance with P T A scales, i e , £460 to £765 per annum, according to qualifications and experience —Applications, in writing, giving names of three referees, to the Superintendent, The United Sheffield Hospitals The Children's Hospital, Western Bank, Sheffield, 10

BRITISH ELECTRICITY AUTHORITY, RESearch Laboratories, Leatherhead, require Junior Engineers Candidates should have a university degree, higher national certificate or equivalent qualification in electrical or mechanical engineering or physics Duties include research on electrostatic precipitation or materials testing or instruments for special applications Salary, N J B Grade 5 £475 to £650 per annum —Applications to D Moffat, Director of Establishments, Winsley Street London, W 1, by April 8, 1955, quote Ref NAT /581

RESEARCH FELLOWSHIPS GOVERNMENT SCIENTIFI ESTABLISHMENTS

The Civil Service Commissioners invite a tion for a number of Senior and Junior Re Fellowships tenable for three years at Gove Scientific Establishments, for research int jects of importance to H M Government are no age limits but candidates must no have a first- or second-class honours degree appropriate subject and must be able to shc dence of a very high standard of ability search At least two years' postgraduate ence will be expected of candidates for Fellowships and at least three years of can for Senior Fellowships Exceptionally a date without the academic requirement, bu can produce evidence of outstanding ability search, may be admitted Remuneration according to individual merit and experien rates between £950 and £1,150 for Senior F ships and between £600 and £800 for Fellowships F S S U scheme applies The of research in which Fellowships may be av if candidates of the requisite high quality themselves, cover a very wide range , and F ships may be tenable at any of a consid number of scientific establishments

Further information and application form Civil Service Commission, Scientific Bran Old Burlington Street, London, W 1, q S4440/55 Provisional closing date Octob 1955, but early application advised

---

UNIVERSITY COLLEGE OI KHARTOUM

SUDAN

Applications are invited for (1) Senior Le ship, (2) Lectureship or (3) Assistant Lectu in Veterinary Physiology and Biocher Salary (1) £E 1 600 by £E 75 to £E 1,97 annum (2) £E 1 150 by £E 75 to £E 1,67 annum (3) £E 1,000 by £E 75 to £E 1,15 annum Point of entry determined by qu tions and experience Cost of living allo at present approximately £E 150 per annum fit allowance £50 on first appointment Pa for appointee and family on appointment, ination and leave (each long vacation after Appointment on contract for three to seven (renewable) with bonus on completion month's salary for each year of service)

Detailed applications (eight copies), n three referees to be received by April Secretary Inter-University Council, 1 G Square, London, W C 1, from whom furth formation may be obtained

---

UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for the newly lished Chair of Physical Metallurgy which be financed out of funds provided by M Richard Thomas and Baldwins Limited, an Steel Company of Wales Limited The Pro will be expected to have a special interest scientific aspects of the fabrication of metals appointment will date from October 1, Initial salary £2,000 per annum with supera tion and family allowances

Full particulars may be obtained from Registrar, University College, Singleton Swansea to whom applications must be se April 30, 1955

UNIVERSITY OF LIVERPOO

CHAIR OF VETERINARY PATHOLOG

The Council of the University of Live invites applications for the Chair of Vete Pathology

Further particulars may be obtained from undersigned, by whom twelve copies of ap tions (one by airmail in the case of ove candidates) should be received not later April 30, 1955

STANLEY DUMBELL,
Registr

UNIVERSITY OF ST ANDREV

The University Court invites applications fc Chair of Botany in the University The Prof will be a member of the United College o Salvator and St Leonard, St Andrews salary attached to the Chair is £2,200 per an plus F S S U and family allowances A towards expenses of removal may be made

Applications (30 copies), including the nam three referees, must be submitted by Apri 1955, to the undersigned, from whom further ticulars may be obtained

D M DEVIN
Joint Clerk to the University C

MASSEY AGRICULTURAL COLLEGE

(UNIVERSITY OF NEW ZEALAND)
PALMERSTON NORTH, NEW ZEALAND
LECTURESHIP IN AGRICULTURAL BIOCHEMISTRY

Applications, closing May 6, 1955 are invited for the above position Applicants should possess a degree in biochemistry and/or chemistry, including organic chemistry taken to an advanced stage and should preferably have had experience in the analysis of foods including dairy products Experience in the dairy industry is desirable but not essential Salary £892 8s to £1,042 8s or £1,092 8s to £1,292 8s, according to experience and qualifications

Copies of conditions of appointment are obtainable from the Secretary, The Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1, or from the Registrar, Massey Agricultural College, Palmerston North, New Zealand

UNIVERSITY ASSISTANT LECTURESHIPS IN MATHEMATICS

NOTICE

The Appointments Committee of the Faculty of Mathematics give notice that they intend to make appointments to two University Assistant Lectureships For one of these offices consideration will be given to candidates who are qualified in statistics The appointments will be subject to the Statutes and Ordinances of the university and will be for three years in the first instance The maximum tenure of a University Assistant Lectureship is five years The persons appointed will be expected to enter upon their duties on October 1, 1955, or as soon thereafter as is practicable The stipend of a University Assistant Lecturer at present rises from £600 a year to £700 a year by annual increments of £25 The salary scale is under review Family allowances are payable

Candidates should send their applications, with the names of two referees, to the Secretary of the Appointments Committee of the Faculty of Mathematics, the Arts School Bene't Street, Cambridge, so as to reach him by April 30, 1955

ROYAL TECHNICAL COLLEGE

GLASGOW

(In Affiliation with the University)

Applications are invited for Two Lectureships in Mathematics In addition to classes for students of Engineering working for the B Sc degree of Glasgow University and the College Associateship, the Mathematics Department provides classes of honours degree standard leading to the Associateship of the Royal Technical College in Applied Mathematics A postgraduate course in applied mathematics is to be offered in 1955-56 Applicants for the Lectureship should have a research interest in applied mathematics preferably in fluid dynamics Salaries will be on the scale, £650 by £50 to £1,350, with family allowances and superannuation, the starting salaries being dependent on qualification

Forms of application can be had from the Secretary of the College

UNIVERSITY COLLEGE OF KHARTOUM

SUDAN

Applications are invited for appointment to Chair of Anatomy Salary £E 2,500 per annum, cost of living allowance at present approximately £E 150 per annum Outfit allowance £50 on first appointment Passages for appointee and family on appointment, termination and annual leave Appointment on contract for three to seven years (renewable) with bonus on completion (one month's salary for each year of service)

Detailed applications (eight copies), naming three referees, to be received by April 15, by Secretary, Inter-University Council, 1 Gordon Square, London, W C 1, from whom further information may be obtained

UNIVERSITY OF SHEFFIELD

Applications are invited for the Chair of Mechanical Engineering Salary not less than £2 300 a year, with F S S U provision and family allowance

Further particulars should be obtained from the Registrar, the University, Sheffield, 10 to whom applications should be sent by April 30 1955

UNIVERSITY OF SOUTHAMPTON INVITE applications for a Leicester Lovell Research Studentship at £350 per annum, commencing October 1 1955, to study the mechanism and kinetics of reactions of epoxides —Apply to Professor of Chemistry by April 30

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Assistant Lecturer in Chemistry Candidates should have special qualifications in Organic Chemistry Salary on a scale £550 to £650 per annum, with membership of F S S U and children's allowance scheme

Applications should be sent, not later than April 30, 1955, to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained

UNIVERSITY OF ABERDEEN

Chemistry Department requires man already trained as Glassblower or prepared to become Glassblower after training University will pay training expenses of suitable candidate Applicants should have done National Service and should have manual skill Wages in range £340 to £480, according to experience and ability

Applications in writing to the Secretary, Marischal College

MINISTRY OF SUPPLY INVITES APPLICATIONS for a limited number of Senior and Junior Fellowships, tenable for three years at the Radar Research Establishment, Malvern, Worcs, commencing in Autumn, 1955 Candidates must be British subjects with normally either a first- or second-class honours degree in an appropriate subject and must be able to show evidence of a very high standard of ability in research Exceptionally a candidate without the academic requirement, but who can produce evidence of outstanding ability in research may be admitted Fellows will be allowed considerable choice of subjects within the fields of interest to the Establishment These include experimental and theoretical research in low temperature physics electrical and optical properties of semi-conductors, infra-red spectroscopy, microwave physics, and electronics For Junior Fellowships candidates should have had at least two years' postgraduate research experience and should preferably be aged 23-26, candidates for Senior Fellowships should have had at least three years' postgraduate research experience and should preferably be aged 26-30 Remuneration will depend on individual merit and will be between £950 to £1,150 per annum for Senior Fellows and £600 to £800 per annum for Junior Fellows Successful candidates will have their appointments brought under F S S U At the expiry of a Fellowship a holder may be considered for an established post at the Establishment if he so desires —Application forms obtainable from the Director, Radar Research Establishment, Malvern, Worcs to whom they must be returned by April 15, 1955, together with suitable testimonials regarding research ability, and, where possible, copies of candidates published papers

MINISTRY OF SUPPLY INVITES APPLICATIONS for a limited number of Senior and Junior Fellowships, tenable for two or three years at the Royal Aircraft Establishment, Farnborough, commencing in Autumn, 1955 Candidates must be British subjects with normally either a first- or second-class honours degree in natural science, engineering or mathematics and must be able to show evidence of a very high standard of ability in research Exceptionally a candidate without the academic requirement, but who can produce evidence ot outstanding ability in research may be admitted At least two years' postgraduate research experience will be expected of candidates for Junior Fellowships, who should preferably be aged 23-26, and at least three years of candidates for Senior Fellowships who should preferably be aged 26-30 Fellows will be required to carry out fundamental research into one of a wide variety of problems associated with the advancement of aeronautics, with particular reference to aerodynamics and aeronautical structures The subjects will be selected according to the training and experience of the Fellows and the needs of the Establishment Remuneration will depend on individual merit and will be between £950 to £1,150 per annum for Senior Fellows and £600 to £800 per annum for Junior Fellows Successful candidates will have their appointments brought under F S S U At the expiry of a Fellowship the holder may be considered for an established post at the Establishment if he so desires —Application forms obtainable from the Director, Royal Aircraft Establishment, Farnborough, Hants, to whom completed forms, together with suitable testimonials regarding research ability and, where possible, copies of candidates' published papers, must be returned by April 15 1955 Overseas candidates should submit written applications stating age, nationality and place of birth of self and parents, educational and academic qualifications, appointments held and research experience

H M OVERSEA CIVIL SERVICE (RESEARCH BRANCH)

WEST AFRICAN COUNCIL FOR MEDICAL RESEARCH

Medical Research Officer required in the Hot Climate Physiological Research Unit, Nigeria, to undertake investigations into Human Physiology, with particular reference to climate, work and nutrition Candidate should be prepared to act for the officer-in-charge on occasion and to travel both in Nigeria and other colonial territories The Unit is situated 10 miles outside Lagos where there are good facilities for a varied social life Candidates should have an honours degree in physiology, possess medical qualifications registrable in the United Kingdom, and have some experience of teaching and/or research Appointment can be made on probation for appointment in the Research Branch of Her Majesty's Oversea Civil Service or on temporary contract with gratuity of 15 per cent of salary payable after satisfactory completion of appointment It is possible that existing superannuation rights could be preserved Selected candidate will be appointed Medical Research Officer, Grade II Salary £800 by £50 to £1,050 a year, plus oversea research allowance of £420 a year Quarters equipped with heavy furniture are available at a rental of 10 per cent of basic salary Outfit allowance on appointment £60 Travelling on duty allowances payable Free passages for officer, wife and children under 13 years of age on appointment and on leave Tours of service vary from twelve to twenty-four months Leave earned at rate of one week for each completed month of duty

Application forms from Director of Recruitment, Colonial Office Sanctuary Buildings, Great Smith Street, London, S W 1 (quoting reference BCD 197/210/06)

BUCKINGHAMSHIRE EDUCATION COMMITTEE

SLOUGH COLLEGE OF FURTHER EDUCATION
WILLIAM STREET, SLOUGH

Principal R Edgar, M Sc, M A

Grade B Assistant for Inorganic Chemistry, required in September Applicants should possess a degree or equivalent qualification

Further particulars and forms of application may be obtained from the Principal, William Street, Slough, to whom they should be returned within fourteen days of the appearance of this advertisement

SOUTH SHIELDS DISTRICT HOSPITAL MANAGEMENT COMMITTEE

Applications are invited from science graduates for the appointment of Biochemist (non-medical) in well-equipped and modern Group Laboratory General Hospital, South Shields Salary either on basic grade or senior grade of Professional and Technical Whitley Council scale, according to qualifications and experience, viz basic grade £410 to £510, and after probationary period £585 to £765, senior grade £835 to £1,080 Post offers facilities for further studies

Applications, accompanied by names of two referees, to Group Secretary, Ingham Infirmary, South Shields, within ten days

UNIVERSITY COLLEGE OF KHARTOUM

SUDAN

Applications are invited for (1) Senior Lectureship or (2) Lectureship in Public Health Salary scales (1) £E 1,750 by £E 75 to £E 1,975 to £E 2 090 to £E 2,170 per annum (2) £E 1,300 by £E 75 to £E 1,825 per annum Point of entry determined by qualifications and experience Cost of living allowance now approximately £E 150 per annum Outfit allowance £50 on first appointment Passages for appointee and family on appointment, termination and leave (each long vacation after first) Appointment on contract for three to seven years (renewable) with bonus on completion (one month's salary for each year of service)

Detailed applications (eight copies), naming three referees to be received by April 15 1955, by Secretary Inter-University Council, 1 Gordon Square London W C 1, from whom further information may be obtained

BOTANIST-BACTERIOLOGIST TO TEACH courses in bacteriology and in public health and some other biological subjects Lecturer or Assistant Professor September, 1955 —Address inquiries to W B Stallworthy, Mount Allison University, Sackville, N B, Canada

COMMONWEALTH of AUSTRALIA

DIVISION OF BUILDING RESEARCH

APPOINTMENT No 390/204 OF RESEARCH OFFICER (RHEOLOGIST)

The Commonwealth Scientific and Industrial Research Organization, Australia invites applications for appointment to a position of Research Officer, at its Division of Building Research Highett, Victoria Duties Investigations into the rheological characteristics of building materials Initial studies will be concerned with bituminous materials Other systems to be studied include clay plaster and lime pastes Qualifications University honours degree in science, with physics and/or chemistry as a major subject or equivalent qualifications Salary Dependent on qualifications and experience, commencing salary will be determined within the range of Research Officer, £A 1,184 to £A 1,730 per annum, thirteen increments subject to efficiency review at £A 1 268 and £A 1,520 per annum Fare to Australia (including those of wife and family will be paid The appointment is subject to a satisfactory medical examination and the appointee may be granted superannuation privileges

Applications, referring to Appointment No 390/204, and stating full name, place date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by the names and addresses of two persons willing to act as referees, if required, and copies of not more than four testimonials, should reach the undersigned not later than May 21, 1955

W IVES,
Chief Scientific Liaison Officer
Australian Scientific Liaison Office,
Africa House,
Kingsway, London, W C 2

UNIVERSITY OF BRISTOL

Applications are invited for the post of Junior Fellow in Applied Mathematics for the Session 1955-56, within the salary-range £550 to £650 per annum The appointment may be renewed for a second year Preference will be given to candidates with research experience in fluid mechanics

Further particulars may be obtained from the undersigned, with whom applications must be lodged not later than April 30 1955

H. C BUTTERFIELD,
Registrar and Secretary

THE RESEARCH INSTITUTE (ANIMAL Virus Diseases), Pirbright, Surrey, will require shortly a number of Research Officers to carry out virus research For certain of the posts candidates must have graduated as M R C V S , and for the others should have an honours degree with postgraduate experience in one of the following fields biophysics, biochemistry, bacteriology and virology The posts will be either on the Senior Scientific Officer grade of £970 by five increments to £1,125 per annum, or on the Scientific Officer grade of £477 by twelve increments to £845 per annum (slightly less for female officers) and will be superannuated under the F S S U Commencing salary will be determined in accordance with age, training and postgraduate experience Housing accommodation available for married staff — Applications stating age qualifications and details of present and past appointments, and accompanied by the names of three persons to whom reference may be made, should be addressed to the Secretary immediately

APPOINTMENTS VACANT

WOOL INDUSTRIES RESEARCH ASSOCIATION

Physicists with honours degree or A Inst P required for fundamental research on (i) Adhesion, friction and abrasion of non-metallic substances (ii) Physical adsorption by polymer materials, including infra-red measurements Previous research experience not essential, opportunity for proceeding to a higher degree Commencing salary according to age and experience in range £530 to £845 per annum, with F S S U benefits

Applications to Wool Industries Research Association, Torridon, Headingley, Leeds, 6

PHYSICIST REQUIRED FOR *X*-RAY DIFfraction and other interesting physical investigations, in a Metallurgical Research Laboratory Good prospects and scope exist Pension scheme —Apply, giving full particulars of age, qualifications and experience, to Box 669, T G Scott and Son, Ltd , 143-147 Regent Street London, W 1, quoting reference PX

ATOMIC POWER DEPARTMENT

of

ENGLISH ELECTRIC

requires

MECHANICAL DESIGN ENGINEERS

This is an excellent opportunity for men with any type of medium or heavy mechanical design experience to enter this new field of engineering

Applications should be made to

Dept C P S ,
336-7 Strand, W C 2,
quoting Ref No 1318A

ATOMIC POWER DEPARTMENT

of

ENGLISH ELECTRIC

invites applications from

MATHEMATICIANS

who have or who will have in the near future, postgraduate qualifications in MATHEMATICS

Please write to

Dept C P S ,
336-7 Strand, W C 2
quoting ref no 1367A

REQUIRED FOR PERMANENT RESEARCH positions in U S A Nine Chemists, Physicists, Metallurgists or Chemical Engineers with excellent scientific background Chemists physicists and metallurgists should have or soon expect Ph D degrees Two Mechanical Engineers, well trained in theory and desirous of applying their knowledge practically Applicants should be aged 25 to 30, eligible to emigrate to U S A University training essential Further academic or industrial experience desirable Salaries commensurate with age and experience and according to U S A scales —Apply in writing, stating country of birth and qualifications to E I du Pont de Nemours and Co , Bush House, Aldwych, London, W C 2, England

INDUSTRIAL RESEARCH VACANCIES (male) for Analyst, mainly inorganic and metallurgical , Physical Chemist and Organic Chemist Also for Unqualified Assistants for chemical laboratory and pilot plant work Pension scheme —Write for application form to Sondes Place Research Institute, Dorking, Surrey

LABORATORY ASSISTANT AGED 23 TO 28 required Experienced in chemical analysis of metals , or alternatively a younger man willing to train would be considered Good prospects Salary according to merit —Apply Chief Personnel Officer, Bryce Berger Ltd , Staines, Middlesex Staines 1122

CHEMIST THE CAPE ASBESTOS COMPany require an Inorganic Chemist for their Research Department, which is located at the Barking, Essex, Factory of the Group The work, which will be under the direction of a senior chemist, involves a study of the chemistry of asbestos, inorganic fibres and silicates Candidates must possess a good honours degree The appointment, which is permanent and pensionable, is for a recent graduate and offers the prospect of a career on the technical side of the Company —Apply, Personnel Manager, Barking, Essex

A I M L TECHNICIANS, OR EQUIVALENT standard, required for pharmacological work Male or female —British Schering Research Institute, Alderley Edge, Cheshire

PHYSICAL CHEMIST FOR RESEARCH WORK

Age 25 to 30 years Salary according to appl cant's ability The Colonial Sugar Refinin Company Ltd , Sydney, New South Wale Australia This company is an old-established on (1855) and its activities cover a wide range, in cluding manufacture of raw sugar, refined suga building materials, fermentation products an chemicals These manufacturing activities exten throughout Australia, New Zealand and Fiji Th successful applicant will work in the first instanc in the company's Research Department, Sydney which employs directly some sixty people, includ ing more than twenty graduates The work o the department includes basic investigations int all the activities of the company

Please reply in the first instance to the com pany's Agents Parbury Henty and Co Pty Ltd 20 Eastcheap, London, E C 3

BREWING INDUSTRY RESEARCH FOUNDATION

NUTFIELD, SURREY

Applications are invited from analytical chemist for a senior research post Exceptional faciliti are available for carrying out and supervisin original work largely of a fundamental natur on the application of modern methods to fermen tation and related problems The post is super annuable under F S S U , and the salary will b on a scale commencing at not less than £1,00 per annum, according to qualifications

Applications giving full details of age, quali fications and experience, should reach the Directo not later than April 9, 1955

WOOL INDUSTRIES RESEARCH ASSOCIATION

Physicist with honours degree or A Inst P re quired for weaving research The work involve experimental and analytical investigations o looms and in the laboratory , it requires mechani cal aptitude and a liking for classical physics Previous research experience not essential Com mencing salary according to age and experience i range £530 to £845 per annum, F S S U benefits

Applications to Wool Industries Researc Association Torridon, Headingley, Leeds, 6

THERMODYNAMICISTS WITH DEGREE O equivalent qualification are required for work o wide variety of problems concerned with tempera ture control and air conditioning for high spee flight A number of vacancies also exist fo Technical Assistants in the above field (Ref 125) —Please write in detail, quoting Ref No of position sought to The Personnel Manage (Technical Employment), de Havilland Propeller Ltd , Hatfield, Herts

ANALYTICAL CHEMIST REQUIRED T work in Department dealing with pesticid residues on crops, atmospheric contamination an micro analysis of organic compounds B Sc o A R I C standard necessary Previous practica experience desirable Salary according to ag qualifications and experience —Write (quotin No 1025), giving fullest particulars and sala required to Personnel Manager, Fisons Pes Control Limited, Bourn, Cambridge

CHEMICAL MANUFACTURING ORGAN ization in London area, expanding its Researc Department, invite applications from honour graduate in organic chemistry, with or withou industrial experience Positions are available i both fundamental research and development sec tions Positions are both permanent and pension able, and the salaries will be appropriate to th qualifications and experience of the candidate selected —Apply Box 675, T G Scott and Son Ltd , 143-147 Regent Street, London, W 1

GRADUATE CHEMIST, METALLURGIS or Chemical Engineer required, to deal with prob lems relating to the installation of electroplatin plant and process control Applicants must hav completed military service and be willing to travel —Apply, Electro-Chemical Engineering Co , Ltd 161 Queens Road Weybridge Surrey

LADY CHEMIST, GRADUATE OR H N C required for analysis of electroplating and allie solutions —Apply, Electro-Chemical Engineerin Co Ltd , 161 Queens Road Weybridge Surrey

PHILIPS BALHAM WORKS LTD , 4 Nightingale Lane, S W 12, requires Graduate in Electrical Engineering or Physics preferably wit experience in electronics for development o nucleonic instruments Permanent appointmen with excellent prospects —Applications should b addressed to the Personnel Officer at the above address

ΗE ASSOCIATED ETHYL COMPANY
ited has vacancies for CHEMICAL ENGIN-
.S The work is concerned with the develop-
t, co-ordination and commissioning of modifi-
ons and new engineering projects Experience
hlorine would be an advantage for one of the
s
pplicants should have at least three years'
rience in Chemical Plants and should possess
ifications equivalent to Corporate Membership
ne Institution of Chemical Engineers
ll positions are permanent and progressive
a Company Pension Scheme is available
ries paid will be in accordance with age, ex-
ence and qualifications
pplications, giving full details of the above
ild be made to The Deputy Manager—
onnel, The Associated Ethyl Company
ited, Ellesmere Port, Cheshire

OUNG CHEMIST REQUIRED BY PRO-
sive firm of Canners for their Scottish
neries Experienced quality control in fruit
vegetable canning Excellent opportunity for
le man Reply in strict confidence with full
ils and salary range—Box 678, T G Scott
Son, Ltd, 143-147 Regent St, London, W 1

UALIFIED CHIEF CHEMIST REQUIRED
progressive Company Canning Fruit and Vege-
es Experience in quality control essential
ellent prospect for first-class man, having the
ity to develop new lines State salary required,
erience and qualifications—Fullest details in
ct confidence, to Box 679, T G Scott and
, Ltd, 143-147 Regent Street, London W 1

CIENTIFIC PUBLISHERS IN LONDON
e an editorial vacancy Applicants should
e a science degree, or equivalent, and wide
er than specialized interests Some training
editorial or liaison work would be an advan-
e Pension scheme—Apply, giving full par-
ilars, and salary range expected, to Box 680,
G Scott and Son, Ltd, 143-147 Regent Street
ndon, W 1

YOUNG GRADUATE IN PHYSICS IS
uired to work at Ilford Limited, Watford, on
physical aspects of photographic problems, in
ticular those associated with the photographic
ct of X-rays and γ-rays—Apply in writing to
search Director, Ilford Limited, Ilford, Essex

NELSON RESEARCH LABORATORIES

ENGLISH ELECTRIC CO LTD,

STAFFORD

have a vacancy for a PHYSICIST having an interest in solid state physics and electronics, to work on the fundamental properties and applications of materials suitable for use in electronic storage devices

An honours degree and some research experience are desirable

Salary at present-day levels in accordance with age and qualifications Please reply to Department C P S, 336-7 Strand, W C 2, quoting Ref 1353B

APPARATUS ENGINEERS STANDARD Telephones and Cables Ltd have vacancies for Apparatus Engineers in the fields of electro-acoustics telephone exchange switching apparatus and electronics switching designs and developments The work is varied and involves carrying through designs and developments to the production stage, together with associated laboratory and investigational work An engineering or physics degree is desirable, but higher national certificate standard will be considered Salaries will be paid according to age, qualifications and experience—Write in confidence, giving full particulars to Personnel Manager, Oakleigh Road New Southgate, N 11

COOKE, TROUGHTON & SIMMS LTD, have a vacancy for an Optical Designer at their York factory Preference would be given to a graduate aged 28-35 with the Imperial College Diploma in Technical Optics The salary would be commensurate with qualifications and experience—Apply in writing to the Personnel Officer, Cooke, Troughton and Simms Ltd, Haxby Road, York

MONSANTO CHEMICALS, LIMITED, WILL shortly have two vacancies for Graduates in the Sales Development Group in London (1) A Chemist, Physicist or Engineer, aged 28 to 33 years, having an interest and preferably some experience in technical selling to a variety of industries (2) An Economist, aged 24 to 30 years, with some industrial or commercial experience, preferably in the chemical industry, to establish a forecasting section within the group Both positions are permanent and pensionable, and may involve travel Substantial salaries will be offered and there are excellent opportunities—Apply in writing in the first instance, giving full details of age, education, training and experience, to the Chief Personnel Officer, Monsanto Chemicals, Limited, 8 Waterloo Place, London S W 1

PHYSICIST OR PHYSICAL CHEMIST REquired for the new Mullard Magnetic Materials Factory at Crossens, Southport Applicants should be interested in the solid state Work involves research and development in the field of magnetic ceramics, and offers good prospects Successful applicant will be required to work at Blackburn initially during which period lodging allowances and expenses will be paid—Apply to the Works Personnel Officer, Mullard Blackburn Works Ltd, Philips Road, Blackburn, Lancs, giving fullest details and quoting ref SO/ML/2

ANALYTICAL CHEMIST REQUIRED BY A company manufacturing cosmetic preparations The successful applicant would be required to undertake interesting work dealing with oils, fats waxes and detergents The main requirement is a practical knowledge of analytical techniques and a degree or A R I C would be an additional advantage The starting salary will be in accordance with qualifications and experience and there are good prospects for the right applicant The company operates a pension scheme—Applications, which will be treated in confidence, should be addressed to the Personnel Manager County Laboratories Ltd, Honeypot Lane, Stanmore, Middlesex

GLASSBLOWER WITH EXPERIENCE REquired by Cambridge Laboratory Furnishers Good pay for suitable candidate—Box 670, T G Scott and Son Ltd, 143-147 Regent Street, London, W 1

HIGH VACUUM STOPCOCKS

Individually Tested and Guaranteed
(A E R E Harwell approved)
New Catalogue on request to
G. SPRINGHAM & Co. Harlow New Town
"The Stopcock People" HARLOW 24108

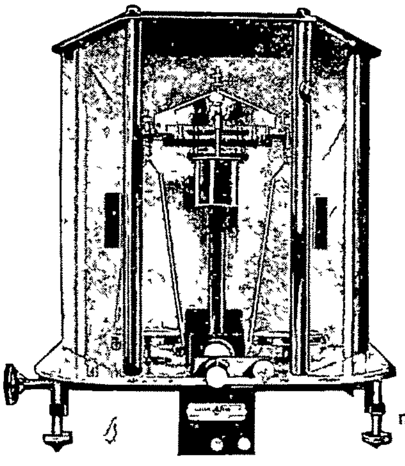
◄ ◄ ◄ ◄ **GRATICULES**
We are now using so many modern methods of processing scales, masks and other graticules on glass that we can find a solution to most glass engraving and printing problems.
PATON HAWKSLEY
ROCKHILL LABORATORIES, KEYNSHAM, SOMERSET
Offices: 389 Archway Rd, London, N 6 KEYNSHAM 2364

OPTICAL FLATS & PROOF PLATES

Your requirements may be listed in our Lens and Prism Leaflet but, if not, we would be glad to quote for making to specification.

Our illustrated leaflets are available on request. Listed are many Second-Hand and Ex-Government items of Photographic, Optical and Scientific interest.

CHARLES FRANK
Instrument Makers and Dealers since 1907
67/73, SALTMARKET, GLASGOW, C.1
Phone Bell 2106 and 2107



The new Aperiodic Balance, using **FLUID** Damping.

✦

Fast, Positive Settlement.

✦

Metal case of modern design

Ask for particulars of the "CRESTA I" Aperiodic Balance.

Sole manufacturers :
WILLIAM A. WEBB, LTD.
1-9 PERRYMANS FARM ROAD
NEWBURY PARK, ILFORD, ESSEX
who will gladly send details on request
Phone : VALentine 6370
Grams · Accuracy, Ilford
Cables · Accuracy, Ilford

ELECTRICAL ENGINEER IS REquired by a well-known chemical concern in the North-west of England, to take charge of the electrical department at one of their large factories The department is responsible for all transforming equipment and medium voltage distribution system is installed in the factory Candidates should be between 35 to 40 years of age and have graduate or equivalent qualifications in electrical engineering At least eight to ten years' industrial experience is essential, together with experience of management Salary will be commensurate with qualifications —Box 672, T G Scott and Son, Ltd , 143-147 Regent Street, London, W 1

GRADUATES IN MATHEMATICS (FEMALE) required for the detailed analysis and tabulation of experimental data Previous experience not necessary —Applicants should write, giving full details to Personnel Department (E D /129), E M I Eng Dev Ltd , Hayes, Middlesex

---

A PHYSICIST IS REQUIRED TO FILL AN important post as Leader of a large Research Group on Solid State Physics He would be engaged solely on research and would work directly with the Chief Scientist, he would not be concerned with development The type of man envisaged is one having a well established reputation in the field of solid state physics and the salary offered would be commensurate with this —Application should be made to the Director, Research Laboratories of the General Electric Company Ltd , Wembley, Middlesex (Ref RLH/21)

PLANT MANAGER REQUIRED FOR EXtraction Plant in East Africa Applicants should have chemical engineering knowledge and be capable of controlling European and native labour Responsible for plant installations and general maintenance Must be conscientious and undertake control of plant process Salary from £1 500 upwards according to experience Home leave, pension and bonus schemes —Write Box "MR/49," c/o 95 Bishopsgate, E C 2

AERODYNAMICISTS WITH A GOOD DEgree and several years' experience in aircraft or missile industry, required to work on a wide variety of dynamics problems associated with major guided weapon development Aerodynamicists with a degree or equivalent qualification, preferably with several years' experience in aircraft or missile industry required to work on analysis and development of flight trials of above weapon Competitive salaries paid for right men —Please write in detail, quoting Ref 119, to The Personnel Manager (Technical Employment), de Havilland Propellers Ltd , Hatfield, Herts

---

APPLICATIONS ARE INVITED FROM Physicists with degrees or their equivalent, for research into machining problems associated with the manufacture of large steam and gas turbines —Apply, quoting reference TJ and stating age, qualifications and experience, to the Director of Research, The British Thomson-Houston Co Ltd , Rugby

---

ELECTRONIC ENGINEERS WITH DEgrees in physics or engineering required for important and interesting work on the research and development of special equipment Good opportunity and high salary rate —Write to Managing Director, Microcell Ltd , 56 Kingsway, London, W C 2

Advertisers please note You must add "Apply Employment Exchange" unless the employment advertised or the workers required are excepted under the Notification of Vacancies Order

---

THE RESEARCH LABORATORIES OF A large chemical manufacturing organization invite applications for progressive posts on their scientific staff The laboratories are well equipped to undertake research by the latest techniques Applicants should preferably have an honours degree or equivalent and be interested in investigational work This work is related to a wide field of manufacturing operations and to product development primarily in connection with titanium and its compounds and particularly the oxide Opportunities exist for those wishing to specialize in analytical, inorganic or physical chemistry, applied chemistry, metallurgy, physics or process development Some of the vacancies will be of interest to students or qualified National Servicemen in their final year The company operates a pension scheme and prospects and conditions of employment are very good The commencing salary will be £500 to £950 per annum, depending on experience and qualifications All applications will be treated in strict confidence —Those interested may obtain application forms and further information from The Research Controller, The Research Laboratories Laporte Titanium Limited, Kingsway, Luton, Beds

---

RESEARCH AND DEVELOPMENT ENGINeers are required for work on Electronic Switching, Computing and Control Apparatus Applicants should preferably have had experience of one or more of the above A good university degree in engineering or physics would be an advantage Further vacancies exist for Junior Engineers and Technical Assistants Excellent opportunities for advancement to more senior positions Starting salary, according to qualifications and experience, will be in the range of £400 to £1,100 per annum The Company operates a superannuation scheme and offers attractive working conditions with generous holiday and leave arrangements, and good social and recreational facilities —All applications will be dealt with in confidence and should be addressed to the Director of Research, British Telecommunications Research Ltd , Taplow Court, Taplow, Bucks

GRANTS & SCHOLARSHIPS

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

ENGLISH ELECTRIC COMPANY'S BURSARIES IN HYDRO-POWER ENGINEERING

Notice is hereby given that a number of English Electric Company Bursars in Hydro-power Engineering will be elected in June, 1955 The Bursaries are of the value of £250 for one year, tenable for postgraduate study in the Civil Engineering Department of the Imperial College Bursars pay the appropriate College tuition fee The Bursaries will be recommended for supplementation by the Ministry of Education Bursars who successfully complete the course will be eligible for the award of the Diploma of the Imperial College (D I C)

Candidates should have an honours degree in Engineering or an equivalent qualification, and applications should be received before June 1, 1955, by the Deputy Registrar, City and Guilds College, Exhibition Road, London, S W 7, from whom further details may be obtained

UNIVERSITY OF SOUTHAMPTON

ESSO RESEARCH STUDENTSHIP

Applications are invited from men who hold or expect to hold a good university degree, with chemistry as principal subject, for a research studentship in chemistry, endowed by the Esso Petroleum Co Ltd , at £350 per annum, to commence October 1, 1955

Candidates should apply to the Professor of Chemistry from whom further particulars can be obtained, before May 14

GAS COUNCIL

RESEARCH SCHOLARSHIPS

The Gas Council invites applications for fi Research Scholarships from graduates or pr pective graduates in physics, chemistry or eng eering at British universities The scholarsh will be awarded for a period of three years fro September 1, 1955, and the universities in whi they will be tenable are as follows Univers of Oxford, Departments of Chemistry , Univers of Cambridge, Department of Chemical Engi eering , University of London, Departme of Chemical Engineering at either t Imperial College of Science and Tec nology or University College , Universi of Birmingham, Department of Chemical Engi eering , University of Glasgow, Department Chemistry The subject proposed for resear must afford scope for original work and be a character approved by the Research Committ of the Gas Council, which is interested in pro lems related to the manufacture distribution use of gas Each scholarship will carry allowance at the rate of £350 a year, togeth with the payment of university and college fee

Particulars and application forms may be o tained from the Secretary, The Gas Council, Grosvenor Place, London, S W 1, or from t Head of any one of the University Departmen named above Applications should be submitt on or before April 15, 1955 to the Secretary T Gas Council, or, if the candidate is a student one of the University Departments named abov to the Head of that Department

UNIVERSITY OF SHEFFIELD

ELLISON RESEARCH FELLOWSHIPS of least £260 p a with remission of fees for researc in chemistry or physics Tenable for three yea from October 1, 1955 Open to graduates British universities Full particulars can be ol tained from the undersigned, to whom applic tions should be sent not later than June 12, 195

A RESEARCH SCHOLARSHIP of £350 p a f research work connected with the chemistry amino-acids, peptides and proteins Tenabl from October, 1955, and renewable, subject t satisfactory progress, up to a period of three year

Applications, giving full particulars of qualific tions and the names of two referees, must b made to the undersigned not later than June 1955

A W CHAPMAN,
Registrar

FOR SALE AND WANTED

FOR SALE, 264 PAIRS PETRI DISHE Czechoslovakian External diameter of top ap proximately 88 mm What offers ?—Horlick Ltd , Slough, Bucks

MISCELLANEOUS

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELOR and WIDOWERS of good character, over 55 yea of age, who have done "something" in the wa of promoting or helping some branch of Scienc

Donations or pensions may be granted t persons who comply with these conditions

For particulars, apply to MESSRS SHE HERD & WEDDERBURN, W S , 16 Charlott Square, Edinburgh, 2

CONFERENCES, FIRST-CLASS ACCOMMO dation (single rooms) and catering, with ampl lecture rooms etc available September an Christmas, 1955, and Easter, 1956 Descriptiv brochure —Apply, Warden, The College of Aero nautics Cranfield, Bletchley, Bucks

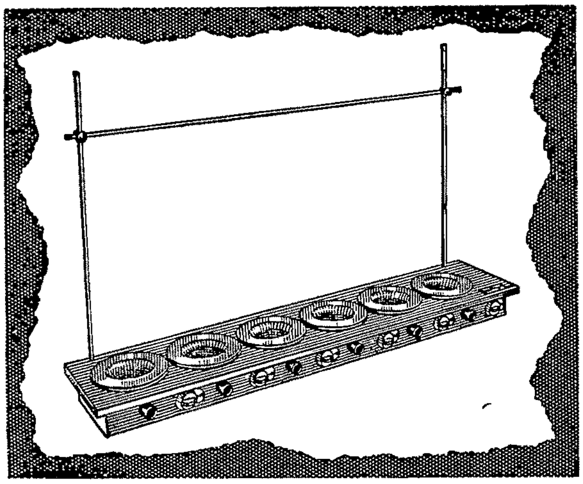
---

TECHNICAL SERVICES BUREAU SPECIALizes in services to scientific and technical authors Preparing MS for press, indexing, proof-reading translations secretarial work —17 Clifford Road New Barnet Herts BARnet 4730

SCIENTIFIC BOOKS OLD, RARE, OUT of-print List free —Walford, 186 Upper Street London, N 1

Secondhand Microscopes
BOUGHT OR
FOR TAKEN
CASH IN EXCHANGE
CLARKSON'S 338 High Holborn, W C I
Opposite Gray's Inn Road. 'Phone HOLborn 2149

T.P.N. TRIPHOSPHOPYRIDINE NUCLEOTIDE
FROM LIVER OR YEAST
and other SIGMA brand products are now available
Ask for list SIGMA 8
GEORGE T. GURR LTD.
136-138 NEW KINGS RD, LONDON, S W.6
The Microscopical Stain People



EXTRACTION UNITS

(*Patented*)

Electrothermal offers the most efficient and up to date equipment for Soxhlet and other tests. Available from your usual Laboratory Supplier in standard 3 and 6 test units—flask capacity 100 ml — 1000 ml. Non-standard apparatus built to specification

Write for leaflet today

Safe, efficient and economical in use.

Electrothermal Engineering Ltd.

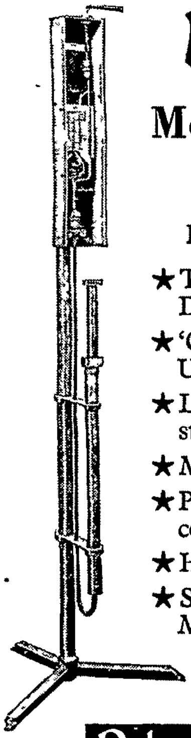
270 NEVILLE ROAD, LONDON, E.7 Telephone GRAngewood 0055

CARL ZEISS

Zeiss instruments of all types repaired and overhauled by Zeiss-trained technicians

DEGENHARDT & CO. LTD.
32 MADDOX STREET, LONDON, W.1
Mayfair 6639

SOLE ZEISS AGENTS FOR GT. BRITAIN AND N IRELAND



Pulsometer

Trade Mark

McLEOD GAUGE

TYPE "G"
with
REPLACEABLE HEAD

★The only breakable part is the Demountable standard Head.

★'O' Ring Sealed Vacuum Unions.

★Lightweight but rigid construction. All Metal Frame.

★Metal Barometric Tube.

★Plunger operated giving fine control and easy operation.

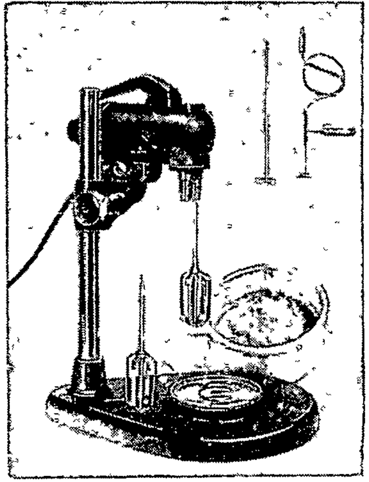
★Hard Gloss Finish.

★Standard Ranges: .1—.00001 M/M. 10—.01 M/M.

Advertisement No 3370

Pulsometer Engineering C°. L^{td}.
Nine Elms Ironworks, Reading.

You get constant speed mixing against load variation



with the

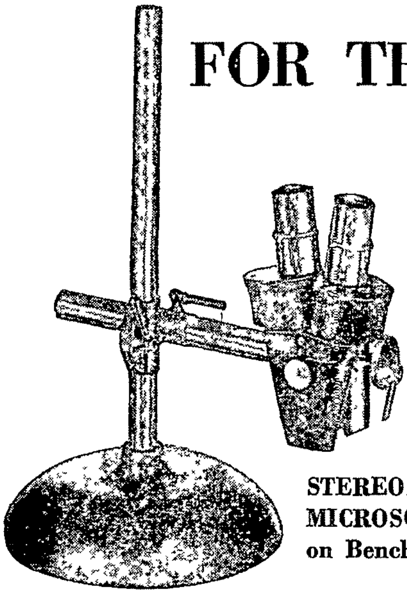
Chemix Major

For quick and efficient mixing of liquids or paste material For 100/110 or 200/250 volts A C Fully adjustable Delivery from stock One example from our comprehensive range of mixers for Laboratory and Industrial purposes Send for illustrated catalogue

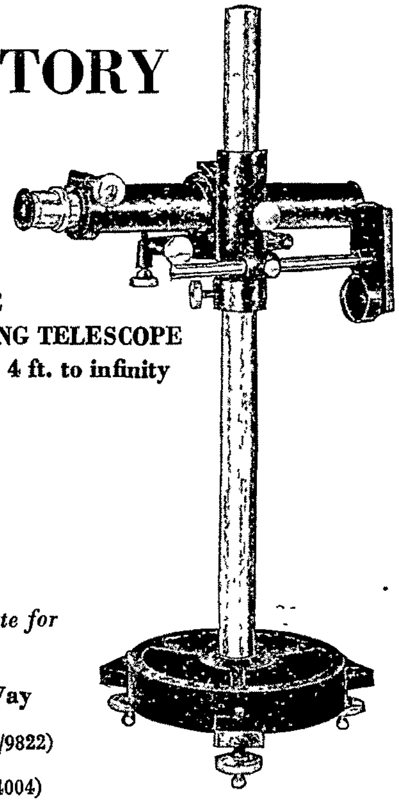
F. & R. M. HARRIS (BIRMINGHAM) LTD.
Chemical Engineers
17-18 DOE STREET • BIRMINGHAM • 4
Telephone CENtral 5585

In association with J K Innes & Co Ltd, Laws Lane, Carlisle

FOR THE LABORATORY



STEREOSCOPIC
MICROSCOPE
on Bench Stand

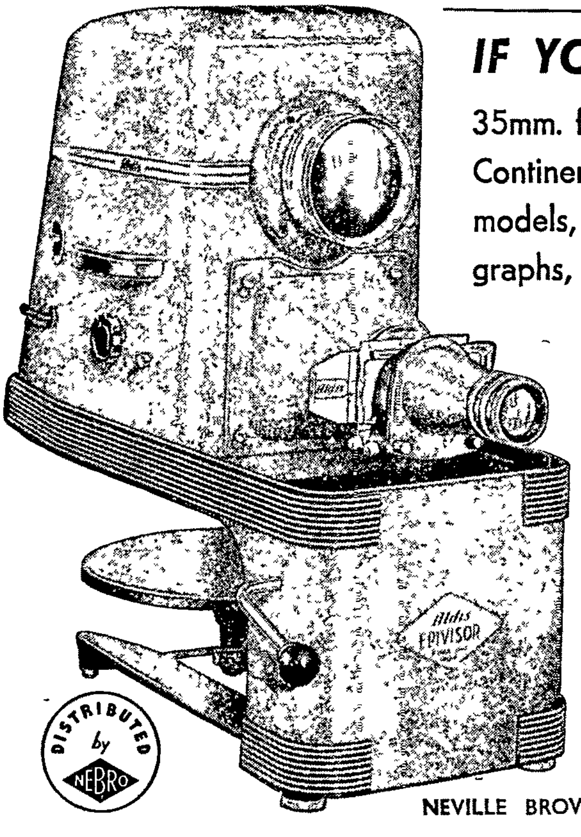


LARGE
READING TELESCOPE
Focuses 4 ft. to infinity

For further details please write for illustrated leaflets

C. Baker OF HOLBORN, LTD. EST. 1765

Metron Works • Purley Way
Croydon • Surrey (Croydon 6644/9822)
Showrooms: 244 High Holborn • London • WC1 (Holborn 1427/4004)



IF YOU WANT TO PROJECT

35mm. film strips, 2"x 2" or 3¼"x 3¼" slides, Continental slides, micro slides, specimens, models, drawings, blueprints, photographs, graphs, etc., etc....

THERE IS ONLY
ONE ANSWER
Aldis
'EPIVISOR'
(Registered Trade Mark)
EPIDIASCOPE

This versatile instrument enables you to project greatly enlarged and perfectly defined images of flat and solid objects, as well as film strips and slides. It is indispensable in research and in training. Full details will gladly be sent on request, together with the name of your nearest dealer, who will be pleased to demonstrate.

DISTRIBUTED by NEBRO

Sole Wholesale Distributors
NEVILLE BROWN & CO. LTD., 77 NEWMAN ST., LONDON, W.1

Manufacturers of optical elements for laboratories and instrument makers

M. Bender (Northern) Ltd.

Optical Works—
5-21, High Friar Street,
Newcastle upon Tyne, 1.
Tel 2-4005/6

Specific Gravity Fluids

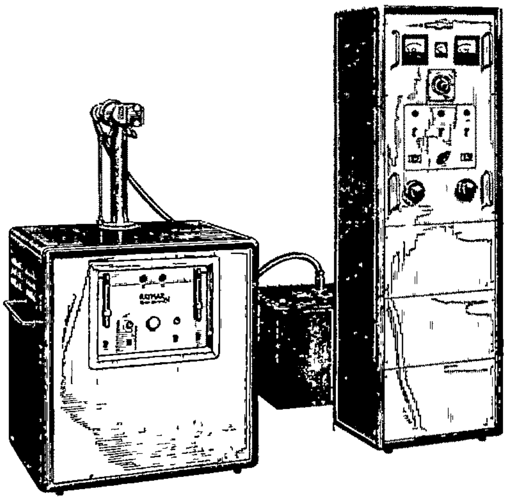
A leaflet will give details of the heavy liquids stocked for flotation tests.

They are available as plain substances which you mix as required, or in sets of mixtures at quite small subdivisions of density.

Please ask us to send a copy

RAYNER
100 NEW BOND STREET, LONDON, W 1
Telephone GRO 5081

Minimum cost Maximum efficiency



RAYMAX 60

X-RAY DIFFRACTION UNIT

The new RAYMAX 60 Unit, comprising a compact 3-piece assembly—occupying minimum space—incorporates a continuously evacuated x-ray tube with demountable target tips, windows and cathode assembly, providing at the minimum initial cost, diffraction facilities which can be extended, as required, for wider service and specialised techniques

Write or ring for further details

NEWTON VICTOR LTD
132 LONG ACRE, LONDON W C 2 COVENT GARDEN 0861
MEMBER OF THE A E I GROUP OF COMPANIES

a New

STABILISED POWER SUPPLY UNIT FOR PHOTO-MULTIPLIERS

Ediswan now have available a new stabilised power supply unit which has been specially designed to feed Photo-Multipliers. It is particularly suitable as a supply unit for Ediswan Mazda Photo-Multipliers type 27 M1, 27 M2 and 27 M3.

BRIEF SPECIFICATION — Type R 1184

INPUT	OUTPUT	STABILITY	OUTPUT RESISTANCE	RIPPLE
200-250 v, 40-100 c p s	High stability low ripple D C supply variable between 300 and 1,100 volts Max current 2 mA Pos or neg may be earthed	A 10% change in mains input voltage results in a change of less than 0 1% between 1,100 volts and 600 volts output	Approximately 1,500 ohms	Less than 0 01% R M S

MOUNTING The Unit is suitable for standard rack mounting or for bench use Bench Stands are available

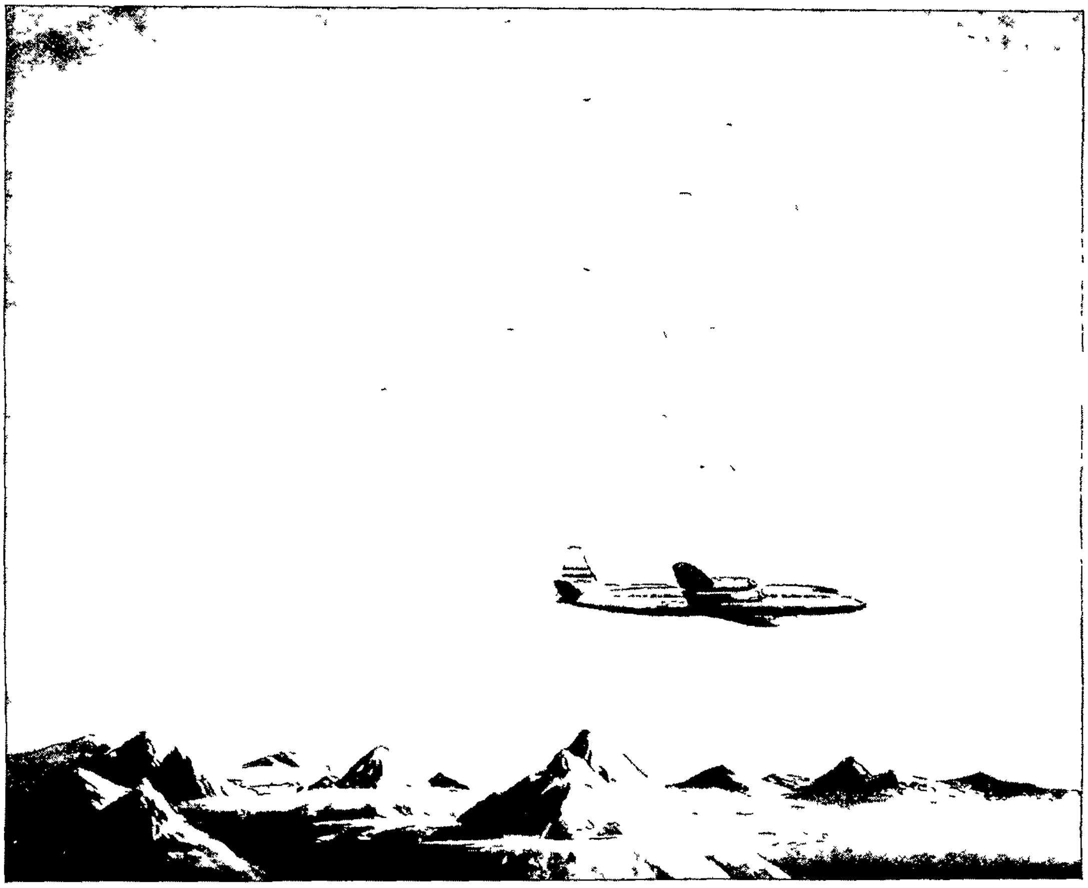
PRICE — £48

Further information is available on request

EDISWAN

RADIO DIVISION · THE EDISON SWAN ELECTRIC COMPANY LIMITED
155 Charing Cross Road, London, W C 2 *Telephone* Gerrard 8660 *Telegrams* Ediswan, Westcent, London
Member of the A E I Group of Companies

SP115



"The Tiger that lurks in the skies"
. . . will FLUOROCARBONS be the answer?

"Fire", the tiger of the skyways has not yet been banished from aircraft—and scientists the world over are still seeking a complete solution to this menace Fluorocarbons may well provide the answer and would seem to offer the highest possibilities of evolving completely fire-proof aircraft
Investigations have shown that Fluorocarbon liquids can replace the inflammable fluids at present used in hydraulic control systems and de-icing equipment Lubricants too can be made of Fluorocarbons—in addition, the application of Fluorocarbons to high speed bearings and inflammable paints is well within the bounds of possibility

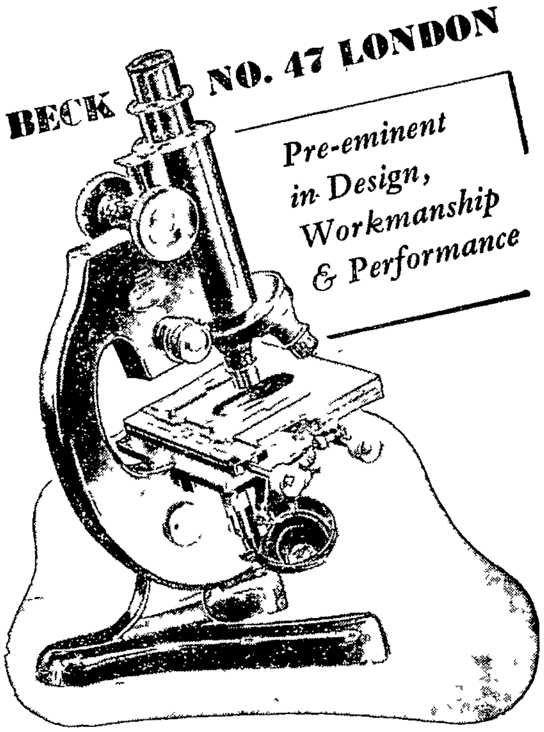
ANHYDROUS HYDROFLUORIC ACID HYDROFLUORIC ACID
BORON TRIFLUORIDE · BENZOTRIFLUORIDE · FLUOSULPHONIC ACID

The above compounds are of great value in the manufacture of fluorinated materials and are available in commercial quantities Industrial applications include catalysts, lubricants, plastics and specialised welding
Should you have any problems or theories on these or any other applications please consult us

IMPERIAL SMELTING
U.K. MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

PIONEERS IN FLUORINE DEVELOPMENT

IMPERIAL SMELTING CORPORATION (SALES) LTD 37 DOVER STREET LONDON W1


BECK NO. 47 LONDON
Pre-eminent in Design, Workmanship & Performance

R & J BECK LTD, 69 MORTIMER ST LONDON, W1

GREEN'S PURE FILTER PAPERS

For all purposes

✦

Write for price list NG

✦

Sole and original makers:
J. BARCHAM GREEN LTD.
Maidstone • England

HAWKSLEY'S
BRITISH MADE
HAEMACYTOMETERS
HAEMOGLOBINOMETERS
SEDIMENTOMETERS
and other apparatus for
BLOOD DIAGNOSIS

COLORIMETERS

McMaster
WORM EGG COUNTING CHAMBERS

EEL WORM COUNTING CHAMBERS

Distributors for Great Britain of
COOKE MICROSCOPES
British made by Cooke, Troughton & Simms, Ltd

HELBER (Bacteria)
and
MANNERS (Eosinophil)
COUNTING CHAMBERS

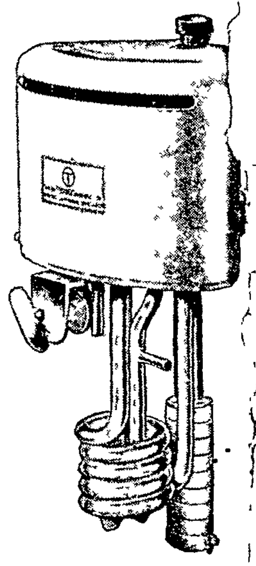
HAWKSLEY & SONS LTD.
17 NEW CAVENDISH STREET, LONDON, W.1
Telephone WELbeck 3859 *Telegrams* "Diffract, Wesdo, London"

TECHNE TEMPUNIT

The Techne Tempunit is a self-contained constant temperature control for fitting to any vessel

- ★ *Indicating Thermostat.*
- ★ *Patented pneumatic control.*
- ★ *±.05°C. in unlagged 3 gallon bath, @ 45°C.*
- ★ *Circulation to external apparatus.*
- ★ *Brushless silent motor.*
- ★ *Rugged solid drawn 1000 W heater.*
- ★ *Efficient four-bladed stirrer.*

TECHNE (CAMBRIDGE) LTD
DUXFORD • CAMBRIDGE • ENGLAND



Printed in Great Britain by FISHER, KNIGHT & Co, LTD, The Gainsborough Press, St Albans, and published by MACMILLAN & Co, LIMITED, at St Martin's Street, London, W C 2, and ST MARTIN'S PRESS, INC, 103 Park Avenue, New York 17, N Y, U S.A.—Saturday, March 26, 1955.